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THE TELEPHONE INDUSTRY.

The report of the directors of the American Telephone and Telegraph Company for last year will give some idea of the telephone development which is going on. It will, of course, be remembered that this report does not touch upon the work of the independent companies. During the year over 600,000 new telephones were installed, bringing the total number used by Bell subscribers up to over 3,375,000—about one Bell telephone for every twenty persons in the United States. These telephones are served by nearly 4,000,000 miles of wire. The daily average of messages was over 10,000,000—that is to say, the telephone was used last year over 3,000,000,000 times where otherwise a letter or a personal visit would have been necessary. The total sum added to construction and real estate, though not as extensive as that of the previous year, amounted to $35,368,700.

LAMP REGULATION ON ELECTRIC CARS.

What at times becomes a rather serious annoyance on electrically operated cars is the decrease in illumination due to variations in the line voltage. On an electrically operated road variations in voltage are much greater than would be allowable on a lighting system, and this is particularly true on long lines where traffic is light. This variation in voltage in no way interferes with the successful operation of the cars, but to avoid the effect on the lamps by adding more copper is a remedy too expensive to be feasible. It is unfortunately true that the illumination of an incandescent lamp varies approximately as the fifth power of the voltage, and for this reason the lamps flicker when a car is started, since at that moment the heavy current drawn by the motors lowers the available voltage at the car. The speed of the car, however, varies directly as the voltage, hence, on long lines, at moments of heavy load, a car may make satisfactory progress, yet the lamps will be so dim as to make reading out of the question; and whenever the car stops there is a sudden increase in the brilliancy of the lamps which is very annoying.

A Simple Regulator.

This disagreeable effect has been practically eliminated on a German road by means of a simple regulating device placed in the lamp circuit. In this particular instance each compartment of the car is lighted by two incandescent lamps placed on separate circuits, so that the failure of one circuit still leaves a light in each compartment. The device which maintains the voltage at the lamps on these cars constant is very similar to the ballast used in the Nernst lamps. It consists of a fine iron wire resistance enclosed in a glass globe from which oxygen has been removed. The resistance of iron increases rapidly with an increase in temperature. The action is as follows: when the voltage across a lamp circuit rises for any reason, an increase in the current flowing through the lamp circuit takes place, but a slight increase is sufficient to increase the resistance of the ballast so greatly that the voltage across the lamps remains nearly constant, resulting, of course, in a much steadier light than is usually obtained on electric cars.

Steadier Lighting Desirable.

It would seem worth while for electrically operated railways on which this variation in illumination is most annoying to adopt some such device as that described. It is simple and inexpensive, and while it consumes a certain amount of energy, this is a small matter; and it is probable that the steadier voltage at the lamps would enable higher-efficiency lamps to be used, so that the final result would not be unfavorable to the ballasted lamp circuit. One of the minor advantages of electric cars is the better illumination provided as compared with that found on steam roads; but if the latter adopt electric lighting, the electric roads may be forced to improve their methods.

THE TRANSFORMER FIRE HAZARD.

The discussion of the transformer fire hazard at the recent meeting of the American Institute of Electrical Engineers showed that there is a wide diversity of opinion among engineers, although the greater number of those taking part were very emphatic in their views of the relatively small risk incurred from the installation of this apparatus. The discussion turned upon the fire hazard of any transformer, as well as upon the relative hazard of the air-blast and the oil-cooled types. It can not be denied that either type of transformer does involve some fire risk, but this is true, to some extent, of practically all machinery. The actual risk involved depends more upon the danger there is of this apparatus taking fire than upon the inflammable character of the material used in its construction.

The Air-Blast Type.

The facts in the case may be stated briefly as follows: the air-blast transformer has solid insulation, and, compared with the oil-insulated type, comparatively little of it. In case this takes fire there is not much to burn. On the other hand, this type of transformer takes fire more easily than the other from internal trouble, and should a fire be started this would probably be encouraged by the blast of air. The result might be an exceedingly fierce fire for as long as the insulation lasted; and if the heated air were discharged in the room, the fire might spread to other apparatus. This type of apparatus is also less protected from external heat than is the oil type.

The Oil-Insulated Type.

The oil-insulated water-cooled type brings into the transformer room a large quantity of combustible material, but this material is so placed that there seems to be comparatively little risk from it. Fires from internal sources may be due to a breakdown in insulation, causing an arc, or to excessive overload. But arcs are quickly extinguished by the oil, and the overload would have to be very great and continue for some time in order to set fire to the oil. The risk of setting fire to the oil from an external source seems to be no greater. This type of transformer is usually enclosed in a strong iron case with an air-tight cover. Experience has shown that, under these conditions, and provided water is kept circulating through the cooling coils, these transformers will pass through fierce fires without being materially damaged and without having the oil set on fire and thus add to the flames. To secure this condition it is necessary not only that the transformer be enclosed within a strong case and the cooling pipes be amply protected from damage, but it is just as essential that the transformer be placed on a substantial foundation—one which will not give way from the effects of the fire and, by overthrowing the transformer, pour out the oil.

As regards draining off the oil in case of fire, opinions differ. It is probably true that the oil can be run out without risk, and in this way the danger of its taking fire be removed; but this action leaves the transformer unprotected. If the case then be filled with water, the transformer is safe from external fire, but will, in all probability, be laid up for several days before it can be dried out sufficiently to be put back into service. This would probably be a good plan to follow in case of a severe fire where the plant would be crippled anyhow.

Fire Hazard Can Be Made Small.

Reviewing the conditions, it may be said that each type of transformer is suited to certain conditions, and, when properly installed, would seem to involve but little risk. It would seem good practice to provide means for shutting off the blast from the air-cooled transformer and for carrying away the heated air. Water-cooled oil-insulated transformers should have strong cases, be placed on solid foundations, and have a thoroughly protected water supply. The oil-insulated air-cooled transformer will probably be installed only in small plants, where simplicity is most desirable. In any case, it would seem good practice to separate the transformers from the other machinery, and this would not seem to complicate matters much, since the high-tension wires would then enter the transformer house only, and not the power-house. There is not much difficulty in carrying the low-tension wires through a fireproof wall. The fire hazard of the transformer can be made small, but only through careful design and by observing the proper precautions in installing.

ELECTRICAL REFORMS.

A bill is now before the legislature of Maryland for the regulation of electrical work in Baltimore. This bill calls for the appointment by the governor of an unpaid commission to serve four years, which shall examine all persons desiring to engage in the business of electrical contracting, which, according to the bill, embraces all the wiring, machinery and appurtenances of light, heat and power service. Persons who satisfy the commission will receive a certificate granting them the right to engage in this business. The expenses of the commission are to be paid out of the fees charged for the certificates issued. The act specifically exempts electric light, electric railway, steam railroads and telephone and telegraph companies from doing the work in their own buildings or in their own plants.

Reform Should Apply to All Systems.

A commission of this kind could, no doubt, improve the character of all electrical work, and thereby reduce materially the fire hazard due to unsafe wiring. Since each contractor would be held strictly responsible for the work done by his employés, he would see to it that he had only responsible men. But why limit this act to electrical work only. Why not make it cover all systems distributing light, heat and power? It seems absurd to restrict electrical methods only, since there are other systems which are more dangerous. The electrical fire hazard is one of the best, and, as for danger to life, the report of the board of gas and electric light commissioners of the commonwealth of Massachusetts for last year shows that there were over twelve times as many deaths from gas as there were from electricity.

Commission Should Be Paid.

One feature of this bill is very pretty on paper, but it is to be feared it will prove something of an obstacle in practice.

The commission is to work without pay. The members must be competent and thoroughly informed as to the requirements of electrical workers. While possibly the duties of this commission would not be very arduous, the work itself would be disagreeable, tedious, and would offer no compensation for the time and trouble given. It is true engineers are, as a rule, underpaid, but it is doubtful whether many will be found who are willing to give their services for nothing. This committee can not be classed with the art committee, as the work is of an entirely different nature. There is little doubt but that the city would secure more satisfactory results if the commission were paid for its services, or the law were altered so that the certificates might be issued by some city officer. The city of Baltimore has in its employ a number of engineers entirely competent to take charge of this work and conduct it more satisfactorily than could any unpaid commission. One feels little responsibility for work for which there is no compensation.

THE NEED FOR RESEARCH.

In his annual report, President Henry S. Pritchett, of the Massachusetts Institute of Technology, very properly calls attention to the need of encouraging research work in this country. Although we are not surpassed in putting scientific discoveries to practical use, we are not doing our share of the patient and painstaking experimental work from which these discoveries result. It is true that we have some capable men who have contributed and who are contributing material to scientific knowledge, but there are not as many such men in this country as there should be, and those we have are, in general, hampered with an excessive amount of instructional work, and often by poor and insufficient equipment. Although our large manufacturing companies maintain their own experimental laboratories, the work there is usually conducted with a definite end in view, and investigation can not be carried out merely for the sake of clearing up some misty subject, unless it promises profitable returns.

Research Difficult at the University.

At our universities, where the real research should be conducted, many circumstances combine to make this difficult and, in many cases, quite impossible. The first duty of a head of a department is to instruct, and the needs of his classes must be provided for before he can devote any time to his own work. He is not only tied down by lack of funds and overloaded with classroom work, but in the greater number of our large institutions instructors are expected to do a large amount of clerical work which should never fall upon them. A young man may start out with the highest resolves and a firm determination to advance his science, but, even when he has laid out his time to the best advantage, after the daily grind of classroom and laboratory, he is quite unfit for serious research.

Poor Reward for the Scientific.

There is another force at work which also interferes with scientific progress in this country. The instructor, though overworked, is underpaid, and he therefore can not be blamed if, instead of carrying on true scientific work, he attempts to turn to the advantage of his pocket any discoveries or inventions which he may make. He feels that he owes it to his family to provide for the future, and he sees no way of doing this as long as he sticks strictly to pure science. This is well illustrated by a little of the personal history of one of our most celebrated scientists. His work was recognized the world over as unsurpassed, for he combined with the highest scientific attainments remarkable aptitude and an untiring spirit. For a university instructor his income was probably above the average, but it was far below that which could be commanded by a man of comparative standing in commercial life. He decided to provide for his family, in case of his death, by life insurance, but this was refused him. Knowing that he had but a few years to live, he then had to decide between providing for his family and carrying the work to which he had devoted his life as far as might be before the end. Can any one blame him for having turned all his energy and ability to developing a valuable invention which would provide for the future? This he did, but no one can tell how much science lost thereby.

Improve the School System.

Are not our methods of instruction also partly to blame for this lack of the spirit of research? Our boys are expected to be men, and yet they are treated as boys until they graduate. They have the daily routine of classes to attend, examinations to go through, and each department is compelled to handle such a large number of students that it is out of the question for them to come into personal contact with the instructor. The student learns of many of the drawbacks of a life devoted to science; he knows that the reward is slight, and there is little wonder that but few of them are willing to make the sacrifice. We pride ourselves upon our school system, but we should not be satisfied with it. Is there not room for improvement and should not this be made, whatever the cost?

POWER PLANS FOR THE GREAT FALLS OF THE POTOMAC.

BY J. E. PRICE.

The employment of the power of the Great Falls of the Potomac river for manufacturing and other purposes has from time to time occupied the attention of capitalists; but up to present date no harness has been put upon these waters. That the value of this power was long ago well understood is seen in the fact that the parties who utilized the falls of the Merrimac river, and so in great measure made the city of Lowell, offered $300,000 for the Great Falls water property before giving attention to the Merrimac enterprise.

This offer was refused. Later—just prior to the Civil War—the property was purchased for the establishment of textile factories, but the plans were frustrated by the war.

The Great Falls Manufacturing Company, having the late General Benjamin Butler for president, next took up the scheme, but failure followed, and the land and water rights were sold by the Butler heirs to parties who in turn sold out to the present owners, the Great Falls Power Company.

The old prospectus informs us that the Great Falls Manufacturing Company owned 900 acres, of which 200 acres were

to be used along the river for mill purposes. The remaining 700 acres were for a foundation of a city, the establishment of which got as far as plans and drawings.

The scheme of the company was to operate its mills by direct water power, aided, when needed, by steam machinery. The power of the falls was estimated at 13,000 horse-power, sufficient for 20,000 looms, aggregating 900,000 spindles. The point of the greatest amount of available power was put near Great Falls, where the river is nearly half a mile wide and is divided by a chain of islands located near its centre, giving two currents, the Virginia and Maryland channels, the former being the main stream. At this point, it is stated, there is about eighty-five feet of fall and a flow of 2,100 cubic feet per second. The elevation of the main falls above high-tide water at Georgetown, a distance of fourteen miles, is given as 158 feet.

The river here presents an effectual obstruction to navigation, but this difficulty was in a measure overcome nearly 120 years ago, when George Washington constructed the Potomac canal, a waterway beginning about half a mile below Great Falls and again entering the river at a point the same distance above. From this enterprise grew the Chesapeake & Ohio canal, which runs from Georgetown, D. C., to Cumberland, Md., a distance of 184½ miles.

It is strange that the city of Washington has not been benefited long ago by the power of Great Falls, going to waste comparatively near at hand. This idea occurred in 1894 to a progressive United State senator, and soon after a Senate resolution called upon the War Department for a report on the feasibility and advisability of utilizing the Great Falls for lighting by electricity the public buildings and grounds and the streets of the District of Columbia. For this work a board of officers of Engineer Corps, consisting of Colonel G. H. Elliot and Captain John G. D. Knight, was appointed, and in time a report was made.

It was determined by the board of engineers that the only place on the Maryland side of the river near the falls available for a power canal was occupied by the Chesapeake & Ohio canal. On the Virginia side the land retires from the foot of the hills leaving a sort of plateau extending from above to below the falls. Through this a power canal could be made and a power station could be established at reasonable cost in this neighborhood.

Concerning the amount of power to be obtained from Great Falls, it can be stated that estimates for this have been based upon reliable records, principally Washington acqueduct observations. From these it is found that when the river is at its lowest stage the flow is at the rate of 1,065 feet per second. The horse-power available at the lowest stages is 7,524, and taking eighty-five per cent as the efficiency of turbines, the energy of a series of turbines below the falls at the lowest stage of the river would be 6,395 horse-power. The gross horse-power is 7,524 and 10,175, differing by 2,651. This difference corresponds to a flow of 375 cubic feet per second. Were this additional flow provided for during the period of low water, the effective horse-power would be increased to 8,648. The only way to provide for this would be by a dam located several miles above Great Falls; with this a comparatively uniform flow could be maintained.

The general plans for an operating plant are set forth by the report as follows: "vertical turbines directly coupled to comparatively low-tension alternating-current generators. The potential of the current to be raised by transformers to 10,000 volts and transmitted by an aerial line to the city limits and thence to a convenient distributing station in Washington by underground cables, and there used to actuate polyphase motors. These motors to be mounted on shafts, to which shall be coupled armatures of direct-current dynamos, each generating unit to be for 100 or 125 lights."

An approximate estimate of the cost of all hydraulic and electric plants, buildings, aerial line, conduits and lamps for the purpose given was $3,764,930. The following is the itemized cost: hydraulic plant of 12,800 horse-power (this allows for great increase of power), $64,000; building for same, $51,200; electric plant, $109,710; aerial line, $102,150; distribution plant, $250,000; building for, $20,000; cable for mains and lamps, $492,600; conduits, $2,250,000; lamps and standards, $424,970.

Hearing that the Great Falls Power Company intended getting to work on its plant in 1904, the writer made enquiries concerning the amount of power this company expected to get from the falls. He was informed by one of the high officials of the Washington Railway and Electric Company—comprising the Metropolitan, Columbia and Great Falls roads— that the minimum output from the falls would be about 13,000 horse-power; maximum, by employment of large storage areas. And it was readily stated that Great Falls power could be made to run all street cars in the District, supply light current and, perhaps, operate a number of factories.

The Great Falls Power Company's business will be the supplying of power to those who wish to buy it. The Washington Railway and Electric Company will be a user of this power. A part of this company's road system now extends to Cabin John's Bridge, six miles from Great Falls. Another road, the Great Falls & Old Dominion, will run to the Falls. But this line—the contract for the building of which has recently been let—will have a steam-electric plant, yet it also may take power from the Falls company.

The power required for street car service in the District of Columbia would have to operate over thirty-seven miles of double and 9.93 miles of single track, underground electric system, and twenty-eight, eighty and 2.96 double and single track, respectively, overhead electric. More than 300 cars would require current daily, and the amount of this would be about two and one-half kilowatts per car-mile.

It is probable that the Great Falls Power Company will put up a steam-electric plant in connection with the hydraulic scheme. The latter system will have its plant located about one mile below at a point on the river and opposite the lower portion of Falls Island, property partly owned by the United States.

A Statement Concerning the Manufacture of Incandescent Lamps.

In connection with the meetings held at the Manhattan Hotel, New York city, on several days of this week, of the manufacturers of incandescent lamps, which meetings have been largely attended, it is rumored that the Sawyer-Man Electric Company, controlled by the Westinghouse Companies, will not enter any consolidation, as reported in the daily press. Furthermore, it advises that it will defend, at its own expense, any or all suits or proceedings that may be instituted against the buyers of its products for the infringement or alleged infringement of any patent or patents, by reason of the sale or use of any of the Sawyer-Man incandescent lamps, provided it is notified in writing of the infringement suit or proceedings, in order that its counsel may be able to act effectively.

It further says that the Sawyer-Man Electric Company is the oldest electrical company engaged in the manufacture of incandescent lamps, and the owner of a number of basic patents under which other companies are manufacturing lamps.

THE ELECTRIC STEEL FURNACE AT GYSINGE, SWEDEN.[1]

BY F. A. KJELLIN, GYSINGE, SWEDEN.

The problem of smelting steel by electricity attracted years ago the attention of inventors, and as early as 1879 C. W. Siemens constructed his first furnace for the smelting of metals, especially steel. His furnace was of the arc type in which the voltaic arc was formed between a carbon electrode and the metallic content of a crucible, the length of the arc being regulated by an electromagnetic device.

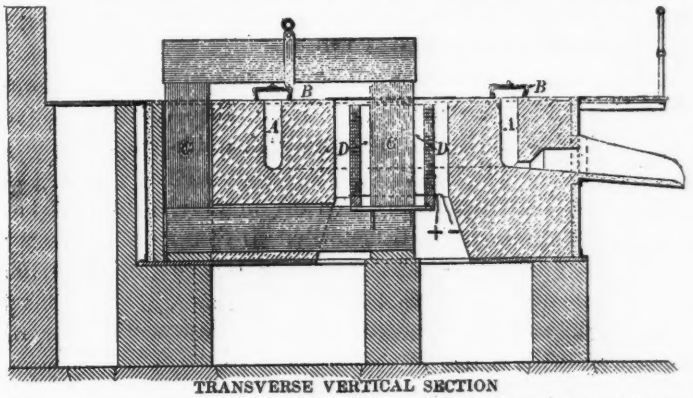
This electric furnace, as well as others of similar construction, has the inconvenience that the source of the heat—the voltaic arc—possesses a temperature of 3,700 degrees centigrade, which is much more than that required by steel-smelting. The result of the use of this intense heat is that the steel is overheated in the vicinity of the arc, while in other parts of the furnace it has not yet reached the temperature suitable for teaming. Another inconvenience is that the steel very easily takes up impurities from the electrodes consumed.

The cost of the electrodes also is an item that sensibly increases the cost of production, and the carbon monoxide resulting from the oxidation of the electrodes exerts a bad influence, as it prevents the steel from giving off the carbon monoxide dissolved in it. A more uniform heating of the steel can be obtained by passing electric currents of great intensity through the steel, and using the heat evolved by the resistance of the steel for the smelting. But as the resistance of metals, even when molten, is comparatively low, the currents used must be so great that copper cables get a section at least as great as that of the steel in the furnace.

Mr. de Leval, the well-known Swedish inventor, has tried to diminish this inconvenience by using molten slag instead of steel as resistance in his furnace; but the results can not have been satisfactory, as the patent has been allowed to expire.

The greatest difficulty in electric furnaces of this kind comes from the electrodes, for the reason that carbon electrodes have high resistance, cause great losses of tension and power, and are soon consumed at the contact with molten steel. Water-cooled iron electrodes could possibly be used, but then the magnetic properties of the iron create new difficulties. In order to get sufficient intensity of current, alternating currents must be used, and then the magnetism causes the concentration of the current at the surface of the electrodes (skin effect), and the result is great current density in the electrodes with great losses of power, and by the influence of self-induction a diminished capacity of the electric generator to convert mechanical energy into electric energy.

In order to eliminate these difficulties I proposed to Mr. Benedicks, general manager of the Gysinge works, in May, 1899, to build an electric furnace at Gysinge, without electrodes. My project was accepted, and I went to Gysinge to carry it out.



TRANSVERSE VERTICAL SECTION

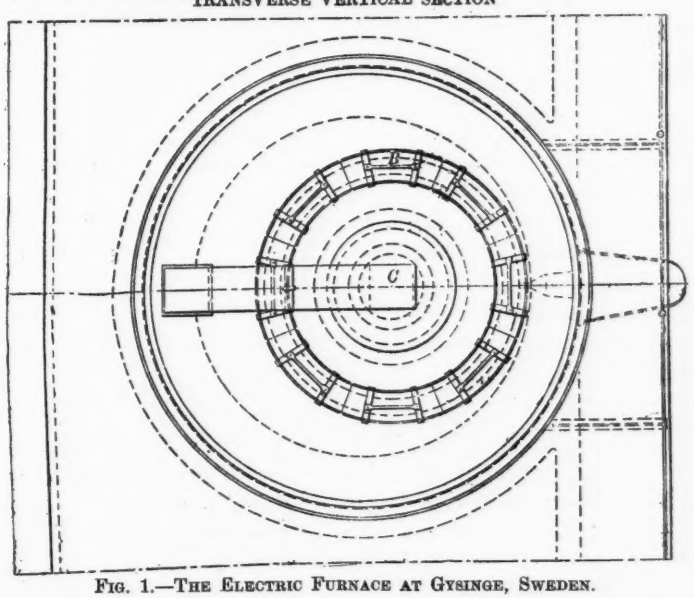


FIG. 1.—THE ELECTRIC FURNACE AT GYSINGE, SWEDEN.

The illustration, Fig. 1, shows the principle of the furnace. An annular groove AA forms the furnace room, the sides and bottoms of which consist of refractory bricks. The covers BB close the furnace. In the centre of the circle formed by the furnace room is a quadrangular core or cone C, formed of thin insulated copper wire, which continues outside the furnace, and forms with the furnace room the two links of a chain. The coil DD is connected with the poles of an alternating-current generator.

When passing through the coil the current excites a varying magnetic flux in the core or cone, and the intensity of current in the steel is then almost the same as the primary current multiplied by the turns of wire in the primary coil. The tension of the current is naturally reduced in almost the same ratio as the intensity is increased. In this way it is possible to use an alternating-current generator of high tension, and yet—without using transformers with copper cables of large sections and powers, and costly electrodes—obtain a current of low voltage and great intensity in the furnace.

In February, 1900, the first furnace at Gysinge was ready for use, and by March 18 the first steel ingot was cast, which, from the beginning, was of an excellent quality. The problem was then solved technically, but not economically, for, with an electric generator of seventy-eight kilowatts, only 270 kilogrammes of steel were produced in twenty-four hours.

The next furnace built was ready in

[1] A paper read before the American Institute of Mining Engineers, New York, October, 1903.

November, 1900, and produced with fifty-eight kilowatts from 600 to 700 kilogrammes of steel ingots in twenty-four hours. The charges were composed of 100 kilogrammes, and the time between the teamings from three to four hours. The output was not fully satisfactory, because the cooling surface of the walls was too great compared with the contents of the furnace, and the cost of repairs was also rather high.

On August 11, 1901, the sulphite pulp mill of Gysinge was completely destroyed by fire, and it was then resolved not to rebuild it, but to use for steel smelting the water power formerly absorbed by the pulp mill.

The new plant was ready to start in May, 1902, and has since that time worked satisfactorily. It consists of a furnace containing 1,800 kilogrammes of steel, from which from 1,000 to 1,100 kilogrammes are taken out by each teaming, and the rest left to keep the current passing. The furnace produces with 165 kilowatts or 225 electrical horse-power, 4,100 kilogrammes of steel ingots in twenty-four hours when charged with cold materials. The electric generator gives alternating single-phase current of 3,000 volts, which is directly transformed, by means of the primary coil and iron core (cone) of the furnace, into a current of about 30,000 amperes in the steel that forms the secondary circuit.

The smelting process is as carried on at Gysinge, producing only first-class steel from the excellent Dannemora pig iron and weld iron as follows:

After teaming, about 800 kilogrammes of metal is left in the furnace to keep the current passing, and to this is added the proper quantities of pig iron, bar ends and steel scrap as experience has proved will give the percentage of carbon desired in the resultant steel. In teaming there is always less carbon in the steel than that contained in the materials charged, for the reason that the pig iron is rusty and the steel also takes up a little silicon by reduction of the silicic acid of the lining. When the charge is molten and overheated to a suitable degree, the teaming is done in the same way as in the open-hearth furnace, by making a hole in the wall. The upper part of the furnace, as shown in Fig. 1, is on the same level as the working floor, and the charging is done simply by taking off the covers and putting in the materials. As the heat is produced in the steel itself, the slag is not so hot as in other steel furnaces, and consequently the workmen do not suffer much from the heat. The steel produced is, as mentioned above, of an excellent quality, uncommonly dense, unusually homogeneous and tough, easy to work cold when annealed, and less disposed to crack and warp in hardening than other kinds of steel. I think that the cause of these excellent qualities, apart from the good raw materials used, must be due to the fact that the product contains less dissolved gaseous matter than other kinds of steel.

As every one knows, even small quantities of gases, especially hydrogen, injure the quality of steel, and the principal cause of the high quality obtained by smelting in crucibles is, in my opinion, that the steel is not in contact with the fuel gases, though it may absorb a little through the porous walls of the crucible. In the electric furnace described above, the steel has no opportunity to take up such gases or other impurities, and the quality is even better than that of crucible steel with the same analysis.

To make special steels with nickel, tungsten or chromium, offers no difficulties, and the alloys themselves are quite homogeneous. The cost of production depends principally on the efficiency of the furnace and the price of the power. In the furnace now in use at Gysinge the losses have been proved experimentally to be 87.5 kilowatts, so that the effective power absorbed by the steel is $165 - 87.5 = 77.5$ kilowatts; and, as those produce 4,100 kilogrammes of steel in twenty-four hours, one effective kilowatt produces about fifty-three kilogrammes of steel ingots in the same time. Every additional kilowatt in the furnace, when the size is not altered, increases the output by fifty-three kilogrammes, and it is calculated that within a few months when a stronger water-wheel is obtained to produce about 6,000 kilogrammes of steel ingots with 200 kilowatts.

As the absolute cost of labor and repair will be the same, those costs for one ton of steel ingots will be about two-thirds of the present cost, and the price of power per ton also will be sensibly diminished. At Gysinge the cost of repair (renewing the lining of the furnace when it is worn out) was $60.

From experience with this furnace it is calculated that a furnace of 736 kilowatts, or 1,000 electrical horse-power, will produce 30,000 kilogrammes of steel ingots in twenty-four hours, when charged with cold materials. With hot materials the output is much greater. For instance, if 250 kilogrammes of molten pig iron are charged for each ton of steel ingots produced, the output is increased from 30,000 to 36,000 kilogrammes in twenty-four hours, with 1,000 electrical horse-power.

In my opinion, the costs of labor and repairs for a furnace of this type will be less than those of an open-hearth furnace of the same size, so that, where power is cheap, there is a possibility of producing a steel competing with the expensive crucible steel at a smelting cost not exceeding that made in the open-hearth furnace.

"Slaves of the Lamp."

In the April issue of the *Strand Magazine* appears an interesting article by Mr. F. T. Godwyn, which describes some of the perils faced by operating engineers in electric generating stations. He tells how cool heads in the face of great danger have taken great risks in order to prevent damage to the machinery and keep the lights burning. The author is evidently an electrical man himself, and although the anecdotes lose nothing in the telling, his descriptions are technically correct and are, no doubt, accurate accounts of what took place in each accident.

The description of a fire developed by a fault in the insulation of a cable connecting a large storage battery to a switchboard is very vivid, emphasis being laid upon the great danger which arises in troubles of this kind. A fire started by a fault in a cable will be maintained as long as there is any power supplied to that cable, and the energy which is being dissipated in the form of heat may be enormous. There is danger to the apparatus in attempting to extinguish the fire by the use of water, and unless the supply of power can be cut off, the only thing that can be done is to prevent the fire from spreading, and wait till the faulty cable breaks or burns in two. Any accident of this kind produces a smoke that is suffocating, yet it must be faced by those who are endeavoring to save the station.

Not all the accidents described are electrical, though they all happened in electric generating stations. The most disastrous was the bursting of the flywheel of a driving engine. Another, which was a severe test of the courage of the station employés, was when the water supply failed and a boiler explosion was feared.

A Correction.

In an abstract appearing in the ELECTRICAL REVIEW for February 20 of a description of the Jungner alkaline cell, by Mr. H. L. Joly, the author's name appears twice in place of that of the inventor, Mr. Jungner. The ampere-hour capacity was given as 130; this should have been 65. The patent referred to was taken out in 1896 by the latter, and the work upon the gelatinous alkaline electrolyte was done by him and Dr. Schoop.—ED.

Hydroelectric Power Plant at Zwolfmalgreien, in Tyrol, Austria.

By Franz Koster.

THIS plant was built for the purpose of supplying the city of Zwolfmalgreien, Austria, with water and electric power, and also to supply power to the outlying districts. The water power is furnished by the Eggen valley river, which rises at the Latemar group which belongs to the Dolomiten range of mountains and is fed by two streams and empties near Kardaun into the Eisack. The rate of flow of the Eggen valley river is at mean tide 2.32 metres (7.6 feet) a second, actual measurement at low water shows a flow of 600 litres (156 gallons) per second. The dam and intake to the water supply tunnel are located at a point about two miles from the power-house, and the crest of the dam is 516 metres (1,742.4 feet) above sea level. The dam is constructed of heavy rubble masonry, is sixty metres (196.8 feet) long and four and one-half metres (14.7 feet) thick at the top, which is sheathed with heavy timbers which can be replaced in cases of necessity. The Eggen valley being narrow, the dam extends from one mountain range to the other. The water enters from the dam through five inlets, which are provided with gratings made of two-inch wrought-iron pipe, in order that all sticks, stones and foreign matter may be prevented from entering the water tunnel. After flowing through the gratings, the water enters through five short tunnels into a collecting chamber which is built at right angles to the supply tunnel. The bottom of this collecting chamber is a few feet below the entrance to the supply tunnel, so that the sand and suspended matter in the water are precipitated to the bottom of the chamber and are carried out into the river by a small sluiceway, one metre (3 28 feet) wide by two and a half metres (8.2 feet) deep.

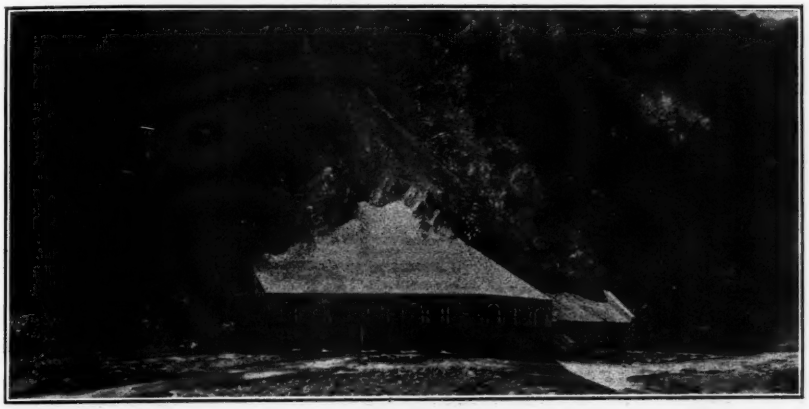


FIG. 1.—DAM AND WATER INLET TO THE SUPPLY TUNNEL, ZWOLFMALGREIEN, AUSTRIA.

At the entrance of the water supply tunnel is placed a grating having openings fifteen millimetres (three-quarters of an inch) wide, and beyond this are located two sluice-gates, each one metre (3.28 feet) wide and two and one-half metres (8.2 feet) high. The intake and entrance to the supply tunnel are solidly constructed of large mountain stones and concrete, and are built against the side of the mountain, as shown in Fig. 1.

The supply tunnel, which is two miles in length, is provided, at eight different points, with sluices in order that the tunnel may be emptied in case of necessity. The bottom of the supply tunnel is lined throughout with concrete, the sides to a point three feet four inches high, and in some cases it has been necessary to use a lining overhead, owing to the character of the soil. Throughout its greater part, however, the tunnel is cut through solid rock and an overhead lining has not been necessary. The light rails which were used during the construction of the tunnel have been placed across it, so as to rest on the concrete lining, and on these rails are carried a plank walk and also on one side the nine-inch supply main for the city water.

The maximum water column in the tunnel has a cross-section of one square metre (10.7 square feet), the slope of the tunnel being one and one-half feet in one hundred, and the velocity of the water is four feet per second. The supply tunnel, Fig. 2, ends in a small collecting basin on the side of the mountain 650 feet above the power-house, this basin being solidly built of concrete. The penstock enters at one end of the basin and is provided with a gate valve which governs the entrance of the water. This valve is operated from a small building located over the penstock, the valve is also equipped with a pipe leading to the atmosphere, in order to allow for the escape of any air which might collect in the pipe. The basin is constructed with a baffle wall running across it and extending up some distance from the bottom, in order to prevent any sand or foreign matter in the water from entering the penstock. The excess water is allowed to overflow into a canal which leads it off to the side of the mountain, and the sand and precipitates are discharged through a sluice-gate at the bottom of the basin, which leads into the overflow canal.

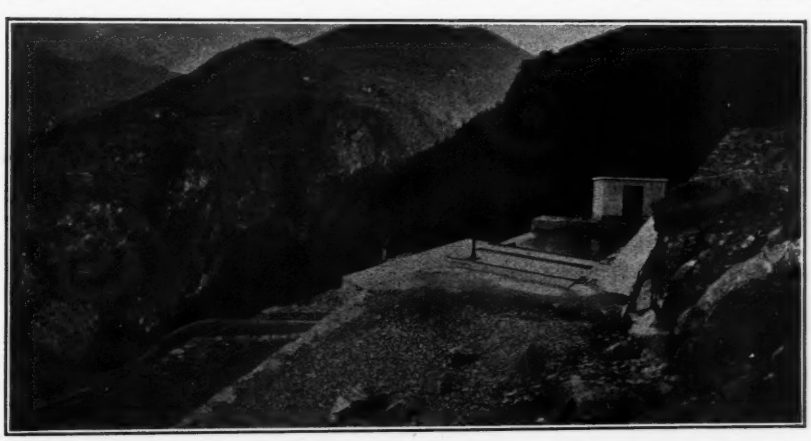


FIG. 2.—COLLECTING BASIN ON PENSTOCK INLET.

The penstock is built of sheet-steel pipe which is made up in lengths of six metres (19.6 feet) each. Each length is built up of a number of plates, the longitudinal joints being double lap riveted

and the cross joints being single lap riveted. The pipe has an internal diameter of 900 millimetres (2.95 feet). The entire length of the penstock, which is 416.4 metres (1,365.7 feet), is divided into eleven sections, in which the thickness of the steel plates varies. This is necessary on account of the variation of the pressure to which the pipe is subjected at different parts, and the thickness ranges from five millimetres (seven-thirty-seconds of an inch) at the first section to fifteen millimetres (three-quarters of an inch) at the lower section. The flanges of the first ten sections are of heavy wrought iron, while the flanges in the last section are of cast steel. The penstock is carried, in its descent of the mountain, on cast-iron supports which are set in concrete foundations, and it is securely anchored at four points, during its descent, where changes in the grade occur. Three expansion joints are provided in the course of its length. The penstock enters at the power-house end into a tunnel thirty-three metres (108 feet) long, which is cut out of solid rock close to the power-house. The gross fall, from the basin to the axle of the turbine, is 210 metres (688 feet), while the net fall is 208 metres (682 feet), the velocity of the water in the penstock is 1.42 metres (4.8 feet) per second, thus giving 2,000 horse-power.

The power-house, Fig. 3, is located at the entrance of the Eggen valley, near Kardaun, on the left side of the valley and about 700 metres (2,396 feet) distant from the Eisack river. The power-house is 300 metres (984 feet) above the sea level and is four kilometres (two and one-half miles) distant from the station at Bozen, which is a well-known resort for travelers. The building covers 374.5 square metres (4,007 square feet), is one story high, with an extension containing a switching room and room for the employés. Under the switching room are located a trench containing the cable ducts and also a repair shop containing 29.5 square metres (315 square feet). The building, up to the floor level, is constructed of concrete, faced with rough stone, and above the floor level is built of cut stone.

The floor is tiled, and in front of the switchboard is a concrete platform fifteen inches high, covered first with linoleum and then with rubber matting for insulating purposes. The floor of the switching room is also of concrete and provided in the same way with rubber matting. The machinery room is equipped with a seven and one-half ton traveling hand crane. The roof is of steel construction, completely tiled, and finished on the inside with metal laths and plaster.

The power-house is lighted by three arcs and a number of incandescents; the arc lamps are connected in series and require a current of fifteen amperes. On the south side of the power-house is built a pipe chamber, two metres (6.56 feet) wide and 1.7 metres (5.5 feet) deep, in which are laid the end of the penstock and the connections to the turbines. This trench is covered with planking.

The end of the penstock is made in the form of a manifold, in which are provided five pipe connections leading to the turbines. Before the first branch is placed an air chamber which acts as a cushion or buffer for the water, and in addition the manifold is equipped with four delicately adjusted pressure relief valves which act to reduce the pressure when it becomes too great. The end of the manifold is provided with a gate valve by means of which the penstock can be discharged. The pipe connections to the turbines rise from under the floor, a gate valve provided with a by-pass being placed in each line. The turbines are of the spoon-wheel type, Rüsch system, designed for a net head of 208 metres (682 feet) and 226 litres (58.6 gallons) per second and run at a speed of 500 revolutions per minute and develop 500 horse-power. The turbines have a guaranteed efficiency of eighty per cent at full load. The water coming to the turbines enters through a ring valve and passes into the intake chamber and thence through a number of slots to the buckets. The slots are cut in a phosphor-bronze casting and the width of their opening is controlled by means of a rack and pinion. This may be operated by hand or may be controlled by a sensitive flyball governor.

The governor, a hydraulic release, connected to a piston, working in an oil dash-pot, and a flywheel weighing 6,500 pounds act to keep the speed of rotation constant. The speed regulation is such that a variation of fifty per cent in the load causes a speed change of three per cent, and 100 per cent change in the load causes a speed variation of six per cent. The above figures are the manufacturer's guarantees. In actual practice, with 100 per cent change in load, the turbine showed a speed variation of only two and one-half per cent.

The equipment at present in place consists of three turbo-generator sets, Fig. 4, and space is available for two more units. The Oerlikon generators are connected to the turbines by means of an isolated flexible coupling. These generators are of the three-phase alternating type, furnishing 500 horse-power at 3,600 volts and fifty cycles and running at the rate of 500 revolutions a minute. The generators are of the internal revolving field type, the bore of the armature being 1,400 millimetres (4.592 feet). The armature contains seventy-two slots and thirty-six coils, each coil having seventeen turns. The coils are made up of two wires, 4 by 4.6 millimetres in section, wound in parallel. The coils are machine wound. The revolving field is 1,390 millimetres (4.559 feet) in diameter, contains twelve poles, connected in series, the polar windings being made up of forty turns of copper band, three by thirty-three millimetres in section, placed on edge. The bands are separated by an asbestos insulation one-half millimetre thick. The exciters are of the Oerlikoner machine type 2, and are mounted overhanging on the generator shaft. They furnish a current of 200 amperes and are provided with twelve carbon brushes, twenty by sixteen millimetres in cross-section.

The main and exciter cables are led

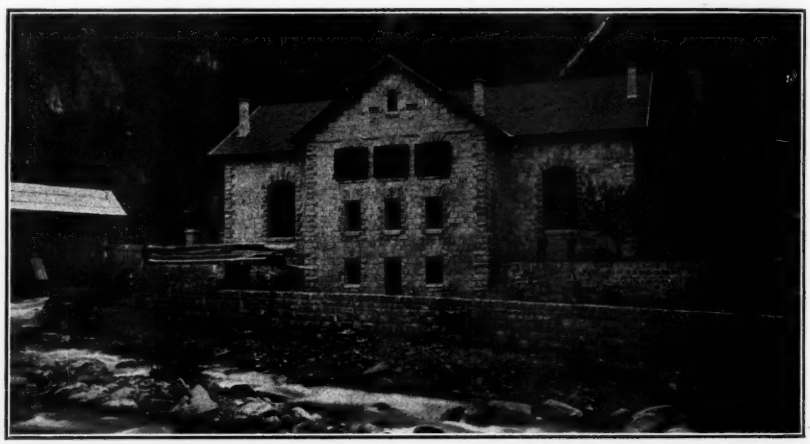


FIG. 3.—POWER-HOUSE OF THE HYDROELECTRIC PLANT AT ZWOLFMALGREIEN, AUSTRIA.

from the machines under the floor in a trench which is covered with iron plates through the basement to the main cable duct, where the high-tension cables are supported on double-petticoated porcelain insulators, and the low-tension cables on porcelain knobs, the insulators being carried on iron supports.

The apparatus room is separated from the turbine room by the switchboard, which is of steel construction faced with white marble. The lower part is faced with perforated sheet iron for ventilating purposes. The switchboard is divided into seven panels, three of which are generator panels. Each of these is equipped with two ammeters, one for the generator current and one for the exciter current, also a lever for operating the three-pole main switch and a hand wheel for operating the regulating apparatus. The fourth panel is equipped with two sets of bus-bars, one for lighting and one for power, and also in this connection two ammeters and two voltmeters, and, in addition, a voltmeter provided with a switch is supplied for measuring the generator voltage. This panel is also equipped with two synchronizing lamps and switch and a hand lever for a three-pole switch for connecting in parallel the lighting and power bus-bars. The apparatus room, Fig. 5, is divided by an aisle, the side toward the turbine room containing a three-pole circuit-breaker for each machine, three single-pole high-tension fuses for each machine, the auxiliary transformers used with the volt and ammeters, each transformer having two primary fuses, and also on this side of the room are located the regulating rheostats. On the opposite side of the room are the collecting bus-bars for light and for power, both sets of buses are of aluminum. Each set of buses is provided with three single-pole fuses and each machine with a three-pole double-throw switch for throwing it on the lighting or power bus-bars, as may be desired. In addition, on this side of the room is located a static transformer of seven-kilowatt capacity, for furnishing current for lighting the power-house and the surrounding buildings.

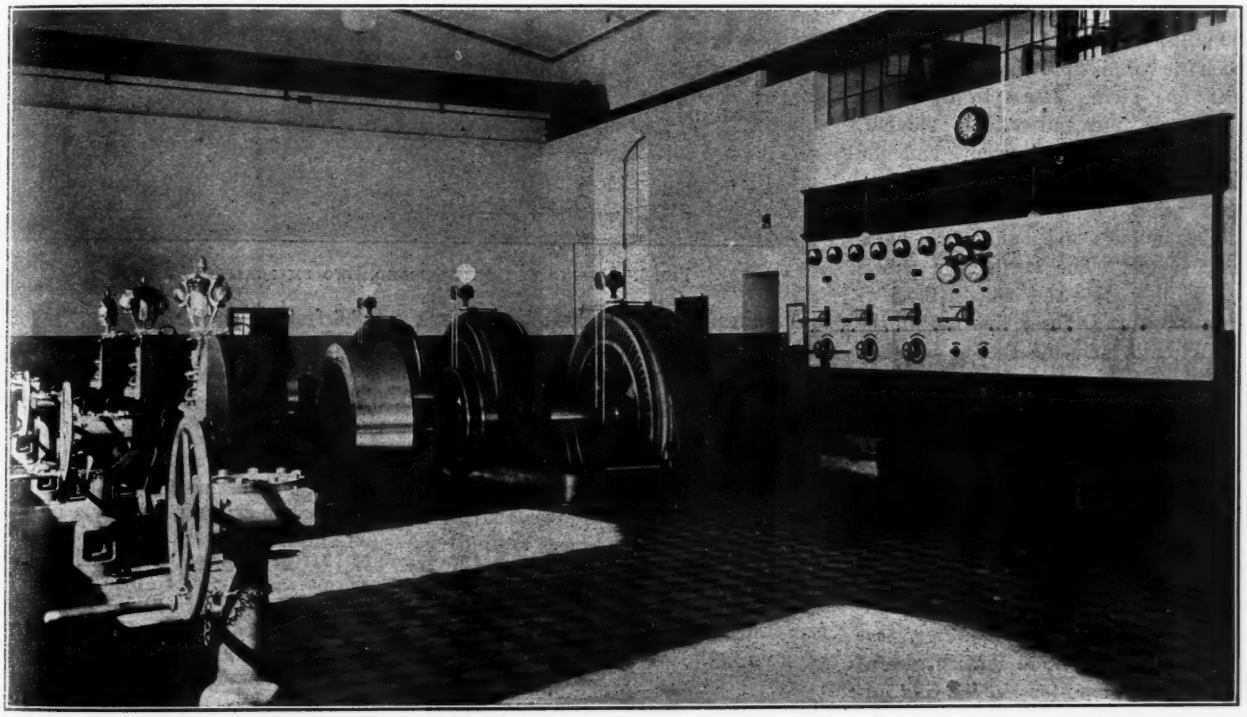


FIG. 4.—THE TURBO-GENERATORS AND SWITCHBOARD, HYDROELECTRIC PLANT, ZWOLFMALGREIEN, AUSTRIA.

From the bus-bar fuses the wires are led through ducts in the wall to the upper part of the addition of the building, where are located the lightning arresters. These are of the horn type, as shown in the illustration, Fig. 6, and are connected to ground by six-millimetre wire.

Corresponding to the two bus-bar systems are two systems of distribution, Fig. 7, one for lighting and one for power. Both systems are run partly by overhead open wiring and partly underground in cables. The overhead wires for lighting and power are of hard drawn copper, seven millimetres in diameter, and run along the left side of the Eggen valley river as far as Zanauerhof, where is located a transformer station; here they cross the river and run along the other side until they reach the Eisack, where the line crosses and runs into a tower. The entire length of the overhead line is 800 metres. The line is carried on twenty-six wooden poles, fifteen metres (forty-nine feet) high, each pole being equipped with a pointed cast-iron cap which is connected by means of six-millimetre wire to an iron plate, 400 by 450 millimetres (fifteen and one-half by seventeen and one-half inches), which is buried in the ground. In case this ground connection should be damaged, the pole tops are connected together by a four and one-half millimetre galvanized iron wire. The tower mentioned above is built of brick and is used for the purpose of bringing the wires from overhead to underground. The interior of the tower contains a number of lightning arresters and a three-pole high-tension switch for each circuit.

The underground cable, containing three conductors, is first triple wrapped, then covered with a layer of paper insulation; over this is placed a sheathing of lead, and over the lead double iron bands, over which is placed a covering of asphalted jute. The two cables are placed together in a trench, 700 millimetres (twenty-seven inches) deep, and are covered with flag-stones.

Three sizes of cables are used as follows: one consisting of three conductors, each having a cross-section of fifty square

millimetres; one consisting of three conductors, each having a section of twenty-five millimetres, and one of three conductors, having a section of fifteen square millimetres, in all ten kilometres (six and one-quarter miles) of cable are used. In this length of cable are included fifty-three laterals.

The transformer towers, Fig. 8, are cylindrical in form and are built of sheet iron and rest upon concrete foundations.

The towers from which the low-tension wiring is carried by means of overhead lines are six metres high, and where the low-tension lines leave in underground cables the towers are four metres high. There are two sizes of towers used, depending upon the number of circuits accommodated, one being 1,420 millimetres (4.56 feet) in diameter, and the other 1,600 millimetres (5.24 feet).

Each tower is provided with three doors: one giving access to the high-tension panel, fuses and switches; another, to the low-tension equipment, and the third, to the transformers. Each high-tension panel contains the transformer high-tension fuses and a three-pole high-tension switch. The low-tension panels are of white marble and contain the low-tension transformer fuses, the fuses in the feeder circuits and the feeder switches. Where a tower contains two transformers they are placed one above the other. In every case the transformer is grounded by means of a copper wire, six millimetres in diameter, which is connected to a copper plate, 500 by 500 millimetres, the plate being buried in the ground. The lighting circuits only are connected to the transformers in the towers. The high-tension power circuits, however, are brought to the towers, so that in case of accident to the high-tension lighting circuits they may be used to furnish current to the transformers. The transformers reduce the pressure to 150 volts for the lighting circuits. It is intended to provide individual transformers for all motors larger than two horse-power, which are fed from the power circuits.

At this time there are in service twelve transformers for lighting purposes, having a total capacity of 137.5 kilowatts. There are seven large and five small transformer towers in service, and several transformers located in fireproof rooms in buildings. In cases where the current consumption is large, and where on account of appearances it is undesirable to carry the low-tension wiring overhead, it is laid underground in the form of cables, the construction of the cable and the method of laying being the same as previously described in the case of the high-tension cables. The overhead construction for the low-tension wiring is considerably cheaper and is used wherever possible. The total length of the low-tension cable amounts to 3.13 kilometres, the make-up of the different cables used being as follows: three wires, fifty square millimetres in cross-section; three wires, thirty-five square millimetres in cross-section; three wires, twenty square millimetres in cross-section; and three wires, with a cross-section of ten square millimetres.

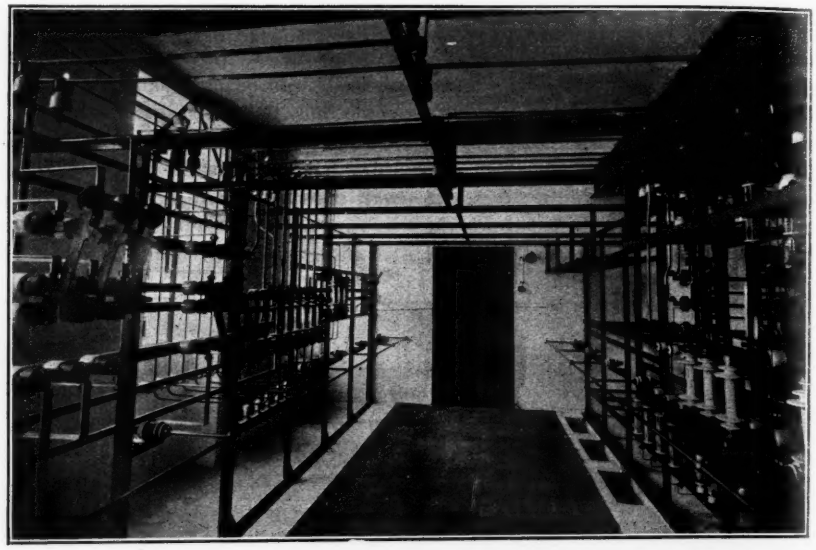


FIG. 5.—BEHIND THE SWITCHBOARD, ZWOLFMALGREIEN, AUSTRIA.

The overhead wiring used for the low-tension circuits is of copper, having a diameter of five, six and seven millimetres, and is carried on double petticoated porcelain insulators, mounted on poles which run from ten to twelve metres high. In addition to the low-tension cables, the pole lines carry the necessary wiring for the local arc and incandescent wiring, these wires being four millimetres in diameter. Each pole is provided with a pointed iron cap, the caps being connected from pole to pole by a galvanized iron wire, three and one-half millimetres in diameter, which is connected to an iron plate buried in the ground at every fourth or fifth pole. The arc lamps, Fig. 7, are hung from ornamental poles or suspended across the roadways. The poles are made of steel pipe and have cast-iron bases and wrought-iron hanging brackets. The lamps are hung at a height of six metres (19.6 feet) above the roadway, are of 800 normal candle-power and take a current of fifteen amperes. They are connected three or four in series. The incandescent lamps are mounted on poles on the walls of houses or on ornamental poles, as in Gries, they are provided with a conical reflector and are protected by a glass casing. The lamps are hung four metres (13.12 feet) above the ground and have a normal candle-power of thirty-two.

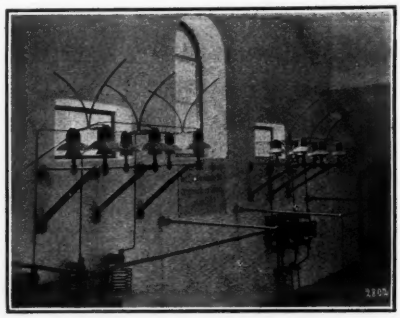


FIG. 6.—LIGHTNING ARRESTERS ON THE HIGH-TENSION CIRCUIT AT POWER-HOUSE.

As previously described, these lighting circuits are controlled from the transformer towers. When this plant first started to operate, in addition to the current supplied for power and street lighting, current was supplied for 2,000 incandescent lamps in private houses, the lamps ranging from five to twenty-five candle-power each. A recent test of this plant shows a considerable gain in efficiency over the guarantees. The Maschinenfabrik Oerlikon, of Switzerland, designed and constructed this plant.

The Trade Press List.

The *Trade Press List,* published at Boston, Mass., is a monthly giving a complete world listing of trade publications. In addition to the complete index of trade publications, each number contains considerable interesting matter concerning the utility and service of special magazines in the different fields, and also information for editors and trade paper managers. The editor of the *Trade Press List* is Mr. Robert Mitchell Floyd.

Rubber Insulation.

The efforts of signal engineers and other users of insulated wires to secure high grade insulation, usually specified as thirty per cent para, are as praiseworthy as they are futile. The larger users have already learned that the best guarantee is the reputation of the manufacturer for turning out wires and cables that stand the practical test of service, and that iron-clad specifications are as unavailing to hold dishonest manufacturers as they are annoying to honest ones. The users of signal cables are now in the throes of the transition period and are vainly endeavoring to draw their specifications, so as to eliminate all possibility of fraud. Details of the specifications are often suggested by certain favored manufacturers who are shrewd enough to make the specifications favor their particular brand. They often succeed in convincing signal engineers that qualities peculiar to their own brand are the true test of good insulating properties, whereas the opposite may be the truth.

This does not mean that definite specifications are altogether useless, but that too much importance should not be attached to them. Let us consider for a moment some of the usual tests and their value. The ash test will determine the percentage of mineral matter, but will not show the quality of the insulating material with which the mineral matter is compounded. Specific gravity is almost valueless in determining the quality of the insulation, as a compound containing little or no rubber can be made to give the same specific gravity as a high grade para compound. Chemical analysis is of more value, but is by no means a sure method of determining either the dielectric qualities or the life of a compound. Extraction by acetone is the usual form of chemical analysis, the extractive matter being resinous. Of this the cheaper grades of rubber usually contain a higher percentage than the paras. There is a decided variation, however, in the extractive matter obtained from vulcanized para compounds, the cause of which it is not necessary to dwell on here. Carl Otto Weber's work, "The Chemistry of India-Rubber," goes fully into this matter. A point entirely overlooked by those basing their opinion of a vulcanized rubber compound on chemical analysis is this: a thirty per cent compound should show seventy per cent mineral matter. Now mineral matter is an adulterant and has little or no dielectric qualities; and a compound showing a large decrease in mineral matter, even if the extractive matter is slightly increased, would indicate a better and longer lived dielectric. The writer has known a compound to

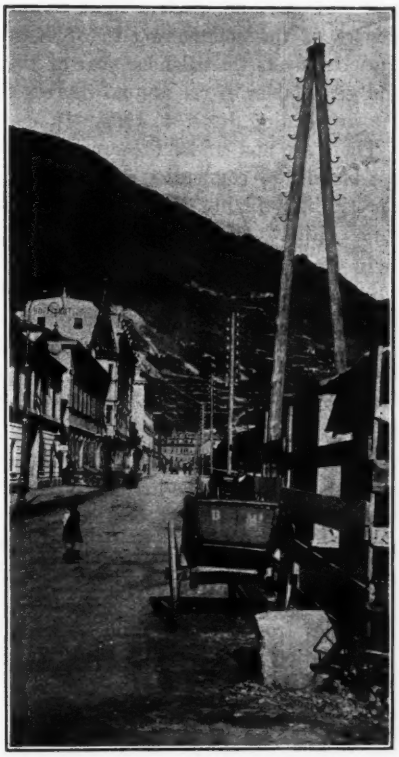


FIG. 7.—DISTRIBUTION SYSTEM AND METHOD OF SUSPENDING ARC LAMPS, ZWOLFMALGREIEN, AUSTRIA.

be accepted showing seventy per cent of mineral matter and thirty per cent of rubber gum, while another compound was

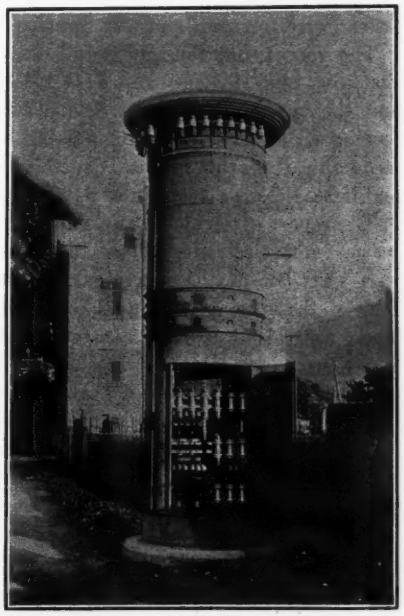


FIG. 8.—HIGH-TENSION SIDE OF A TRANSFORMER TOWER, ZWOLFMALGREIEN, AUSTRIA.

rejected that showed only fifty-seven per cent of mineral matter and forty-three per cent of gum, because the gum showed an increase of about three per cent in extractive matter. The rejected compound was undoubtedly a better and longer lived dielectric.

Some engineers who have been in the habit of using a soft, extremely elastic compound which adheres very firmly to the wire and gives very high insulation, have been persuaded by the manufacturer that these qualities are the only ones by which the dielectric value of a compound can be determined and that any compound not exactly like theirs is inferior. Let us consider this statement.

It is well known that by the use of certain adulterants a much higher resistance can be obtained than by a pure thirty per cent para mixture. The only way an honest manufacturer can meet these excessive resistance tests is by the use of a tubing machine, with which the compound is put on under considerable pressure. This makes it dense and does away with seams, a source of weakness.

A well-known railroad, through its signal department, has recently sent out specifications requiring that a strip of rubber cut from the cable shall stretch four times its length. This is the height of absurdity, and was undoubtedly suggested by some manufacturer who knew it would be particularly favorable to his brand. No properly vulcanized rubber compound will give any such result. It can be obtained only by using such a large percentage of para that the price would be prohibitory; and there would be no advantage in such a compound even if price were not considered; nor by using softening adulterants. That this latter method is employed is proved by the fact that such compounds become very soft, like cold molasses, at a temperature that will not appreciably affect a vulcanized para rubber compound.

A firm adherence of the rubber to the conductor is essential, but even this can be carried too far. As to the three qualities just spoken of, a happy medium would be the following:

The insulation should adhere to the conductor sufficiently to prevent ingress of moisture, but not so as to require a great amount of cutting and scraping before the copper is clean enough to make a good connection. Some users of insulated wires require that the rubber shall be easily removable. This is going to the other extreme. While the rubber is not supposed to furnish mechanical protection, a very soft compound is easily dented and injured by handling even when protected by tape and braid. The rubber should be sufficiently hard to stand ordi-

nary handling and yet soft and elastic enough to sustain no injury from the twisting and turning incident to installing. Excessive requirements in either case, as in the elasticity test just given, tend to lessen the value of the insulation.

Any one familiar with rubber compounds learns through long experience to judge pretty accurately of the value of a dielectric by its general appearance and feeling. This ability can not be imparted nor formulated; it is something like the ability possessed by some bank officials to detect a counterfeit bill among any number of good ones by merely feeling it. The writer has seen an engineer, who believed he knew how to detect at once an inferior compound, cut off a small strip of rubber from a cable, give it a sudden strong pull, subjecting it to a strain far in excess of any it would receive in ordinary use, and, because it broke, pronounce it bad. The same piece gently worked for a few seconds would have shown much greater elasticity and strength, as rubber compounds have a tendency to become set. If a roll of pure para imported splicing tape, the strongest and purest form of para, is kept some time at tension, it becomes hard and seems to have lost all elasticity. Plunge it into hot water and almost instantly it recovers its elasticity fully.

This may seem rather a negative argument, casting doubt on well-known tests and suggesting no better ones to replace them. It is not the use but the abuse of these tests that the writer wishes to condemn. It is the exaggeration of their importance and the lack of knowledge of modifying conditions that do harm.

The engineer should insist on a certain thickness of wall, an insulation resistance test sufficient to show a good factor of safety, say not less than 500 megohms on a 14 B. & S. with three-sixty-fourths inch wall, and in some cases a pressure test. Beyond this he should be governed largely by the reputation of the manufacturer and the practical working of the cables furnished. Moreover, he should not constantly endeavor to force down the prices of a manufacturer who is giving satisfaction by comparing them with quotations from others whose product is not so good. Close bargains are all right, but some consideration should be given to a manufacturer whose goods have proved their value, and he should not be forced into a position of choosing between cheapening his compound or losing the business. The lower grade compounds are as well known to the manufacturer of high-class cables as to the manufacturer of low-class; the difference being that one will use the low grade compound whenever possible, and the other only when he finds that reputation and quality count for nothing as against low price.—*Railroad Gazette, March* 18, 1904.

Gas and Electric Light in Massachusetts.

The nineteenth annual report of the board of gas and electric light commissioners of the commonwealth of Massachusetts covers the calendar year of 1903, and gives tables of the annual returns for the year ending June 30, 1903.

There are now under the supervision of the board 145 companies and the gas or electric light plants of fifteen towns and three cities. Of the companies, forty-eight are engaged in the supplying of gas only, twenty-five in the supplying of both gas and electricity, and seventy-two in electricity only. Of the municipalities, four have plants for the supply of gas and electricity; the others, electricity only.

The report of the meter-testing department shows that of the number of electric meters inspected, about one-half were a little fast and the others a little too slow. In but a few instances was the error of the meter more than two or three per cent.

Replies from all cities and towns with a population of over 1,500 show that no action has been taken during the year toward installing municipal plants.

The financial operations of all the municipal electric plants in the state during the year show that the income from all sources was $191,046.68. The expenses were $283,063.51, leaving an apparent loss in the operating account of $92,016.83. Adding to the expenses interest, depreciation and losses, gives $209,203.87 as the expenditure for town and city lighting.

The report for the gas plants shows that the total income was $147,177.16, and the operating expenses $100,895.28, leaving an apparent profit of $46,281.88. Deducting from this interest, depreciation and losses, leaves a net gain of $10,697.60.

The report of accidents and deaths due to gas and electricity shows that there were sixty-two deaths due to gas, twenty-four of these being attributed to suicide. There were about as many non-fatal cases. There were five fatal accidents due to electricity, all of them being to men employed in some class of electrical work. There were, in addition, seven non-fatal cases, four of these being persons apparently not employed in electrical work.

Statistics of the number of gas stoves used in the state, while incomplete, account for about 150,000 stoves. This figure is probably much too small, as in the large cities the stoves accounted for are only those leased by the gas company.

A summary of the financial operations of all electric light central stations in the state for the year ending June 30, 1903, shows a total income of $7,206,189.83. The expenses were $4,638,991.42, leaving an apparent net profit of $2,567,198.41. Deducting from this the profit the gas companies made in their electrical departments, interest, dividends, depreciation, etc., leaves a deficit for the year of $99,828.93. Seven of the corporations included in this list appeared not to have earned expenses, and thirty others have not earned sufficient to warrant the declaration of any dividend. The amount of dividends declared was $1,225,480.16. The gross profit from electric lighting of all the companies increased $34,705.22, although those doing only an electric business showed a decrease during the last year of $901.23. During the preceding year five companies apparently did not earn expenses, and twenty-five not sufficient to warrant the declaration of dividends. The aggregate of the balance-sheets of the electric light companies only shows total assets of $29,484,264.54, and liabilities of $28,506,621.30. The electric lighting rating of all the companies is given as 1,229,732 incandescent lamps and 21,481 arc lamps.

Electrical Undertakings in England.

The following figures have been abstracted from Garcke's "Manual of Electrical Undertakings." This has been published quite recently for 1904. The actual growth estimated by the aggregate capital invested, exclusive of government telegraphs and post office telephones, has been as follows:

1896	£ 61,109,525
1897	69,209,478
1898-1899	84,742,020
1899-1900	105,977,719
1900-1901	123,636,602
1901-1902	165,807,474
1903	186,158,964
1904	226,926,934

The various track mileages are as follows: tramways and light railways, 5,348 miles; London electric railways, 309 miles; other railways, 260 miles.

As a basis for estimating the probable effect of electrification on steam roads, the following figures are selected. These are of steam roads which have either been converted or are now being converted from steam to electrically driven systems, and in each case the mileage is given: Lancashire & Yorkshire Railway Company, 46 miles; Mersey Railway, 12 miles; North-Eastern Railway, 82 miles; Wirral Railway, 26 miles; Cheshire lines, 2 miles; Manchester & Liverpool Express, 69 miles; North & South Shields Railway, 1½ miles; Seaforth & Sefton Junction Railway, 9 miles; Watford & Edgware, 12½ miles.

The American Institute of Electrical Engineers.

Discussion on the Use of Oil in High-Tension Transformers and Switches—The Value of Group Switches.

THE 185th meeting of the American Institute of Electrical Engineers was held at Carnegie Hall, New York city, Friday evening, March 25, with President Arnold in the chair. The secretary announced that at the meeting of the board of directors, eighty-four associates had been elected, and Mr. J. P. Davis, of New York, had been transferred to full membership; also that the following candidates for officers for the ensuing year had been nominated by the board of directors: president, John W. Lieb, Jr.; vice-presidents, W. E. Goldsborough, J. J. Carty, Samuel Reber; managers, H. G. Stott, Louis A. Ferguson, J. G. White and S. S. Wheeler; treasurer, George A. Hamilton; secretary, Ralph W. Pope.

Mr. Charles F. Scott, chairman of the joint committee for the union engineering building, reported that after the American Society of Civil Engineers had decided not to accept Mr. Andrew Carnegie's offer to erect an engineering building in New York city, the question was raised whether the other three national organizations would be able to accept. By request of Mr. Carnegie, the directors of the three organizations took up the matter again, and expressed their willingness to accept the responsibility; and they reported in writing as to the membership, gave a statement of the financial condition, and submitted letters secured from the officials of a number of smaller engineering bodies, stating that they would be glad to share in the building. Mr. Carnegie then renewed his offer to the three societies, as has already been published.

Mr. Scott said that the joint committee had been at work for the past year developing plans, and it was now in shape to go ahead. Among other plans, an effort will be made to get together the most important engineering library in the world. The plans which were being laid were looking ahead, as it was thought that the building would be a great factor in future progress.

Mr. Calvin W. Rice, as chairman of the building committee, explained the responsibility which the Institute had undertaken. It was necessary to raise $175,000 in order to accept the gift. Up to the present time $40,000 had been raised among the membership alone, leaving $135,000 yet to be secured.

Introductory to the evening's discussion, papers on high-tension transmission were presented, as follows: "Relative Fire Risk of Oil and Air-Blast Transformers," by Mr. E. W. Rice, Jr., read by Mr. F. O. Blackwell; "The Use of Group Switches in Large Power Plants," by Louis B. Stillwell; "Oil Switches for High Pressures," written by Mr. E. M. Hewlett, read by Mr. Calvin W. Rice; "Terminals and Bushings for High-Tension Transformers," by Mr. W. S. Moody. Abstracts of these introductions appeared in the ELECTRICAL REVIEW for March 19.

The discussion was opened by Mr. C. C. Chesney, Pittsfield, Mass., who divided the high-tension switches into four types—switches designed to break in the open air; second, in an enclosed air space; third, with the aid of an enclosed metal fuse; fourth, under oil. The objection to the first type is that a large space is required to make the operation sure, and there is apt to be a high rise of potential upon breaking an arc. Type two is a decided improvement over type one, but the explosion on opening heavy circuits with this switch is often dangerous, affecting not only the switch, but all neighboring instruments. Type three will open safely almost any circuit at almost any potential, but is limited by the amount of space required and the powder set flying by the explosion of the arc. Type four has been recognized within the past year as the only switch for high-tension work. Contrary to the general expectation, the opening of a circuit by an oil switch is not a quick break. The oscillograph shows that the arc continues for several periods, going out, as a rule, at the zero point of the wave. Oil switches for 40,000 volts must have a depth of oil four or five inches over the terminal of the switch. This type of switch is divided into two classes, the plunger breaking the arc in a vertical plane, and the other breaking it in a horizontal plane. The latter has been used a good deal on the Pacific coast. Mr. Chesney described a number of experiments which had been made with oil switches, during which circuits coupled to generators rated at 11,000 kilowatts, with a line potential of 4,500 volts, had been short-circuited and then opened successfully.

A number of points to be considered in designing oil switches were given. The oil should have a flashing point of 215 degrees centigrade, a fire test of 250 degrees centigrade, a specific gravity of 0.865, and should be neutral. The terminal bushings should be either glass or porcelain. The switches should be placed at some distance from the switchboard and other apparatus. All the switches should be controlled either mechanically or electrically, all of the poles of a switch being operated simultaneously. It is also desirable to equip each switch—especially if it is automatic—with a time element attachment, so that the circuit can not be opened for at least a second after the operating mechanism is set in motion.

Dr. F. A. C. Perrine, Pittsfield, Mass., described tests which he had conducted with oil-break switches at San Jose, Cal., ninety miles from the power station of the Standard Electric Company. The line was operating at 40,000 volts, and was short-circuited and opened by means of switches. The tests had to be discontinued on account of a severe rise of potential, which threatened to injure the machinery and the line. This was so great that discharges took place across the lightning arresters through an air-gap of nine inches.

Dr. Perrine differed from the conclusions in regard to the relative fire risk of oil and air-blast transformers. He described three fires through which transformers of the oil type passed. In those cases in which the oil was retained within the case the transformers were undamaged. Where the oil was allowed to flow out, either through upsetting or the giving way of the case, the transformers were damaged. He thought that the fire hazard depended more upon the distribution of the inflammable material than upon the amount. It was important to construct the cases strong enough to resist damage from falling bodies. Provision should be made to protect water-cooling pipes so that circulation might be kept up during the fire. He recommended the installation of transformers in pits which could be filled with water, but not high enough to flow into the transformers. He thought it unwise to attempt to draw off the oil during a fire.

Mr. J. S. Peck, of Pittsburg, Pa., had found that the air-blast transformer is subject to a greater fire risk than the oil type, but, due to the fact that the insulation of the former is in solid form and relatively small amount, it is possible to have such material entirely destroyed with little danger to neighboring apparatus.

There are two sources of danger from the use of oil: the oil itself may take fire, or a vapor may be given off which, when

mixed with air, forms a specific mixture. The nature of the second danger is not generally understood. It has been found that with the best proportions of illuminating gas and air under atmospheric pressure, the greatest pressure which can be obtained from an explosion is somewhat less than 100 pounds per square inch. It is probable that the best mixture of oil, vapor and air would not give a force more than this. Transformer cases should consist of sheet iron with a tight cover sufficiently strong to withstand this pressure. Where a self-cooling sheet-iron case must be used, it is impossible to make this sufficiently strong to withstand the internal pressure of 100 pounds, and in such cases a large safety valve should be provided. Mr. Peck described the fire which destroyed the transformers in the transformer house and threatened the power-house at Snoqualmie Falls, and he thought that provision should be made for drawing off the oil from the case should this become necessary.

Mr. Calvert Townley, of New York city, did not believe that either type of transformer was an extreme fire hazard. High voltages increase the fire risk, but everything possible is done to decrease it. It is a mistake to allow the fire risk to be magnified in the public mind. The air-blast transformer, having but a small amount of conducting material, has, in very few cases, caused serious fires. The chief danger from this type is the presence of the blast of air, which, should a fire start in the transformer, may spread it to other apparatus. This danger should be provided for by properly discharging the air. The air-blast transformer is more subject to damage from external fires than the oil type, because its case is not fire-resisting and is apt to become soaked with water used to extinguish the fire. He cited an instance where the transformers in a station were put out of service for several days for this latter reason, although they had nothing whatever to do with the fire. He regretted the use of the word "oil," which is generally connected with the idea of highly combustible material; but he suggested no other term. Both types of transformers are equally good, and each fills a particular field. There is therefore no need to take a stand in favor of either type.

That the fire risk due to high voltages was greater than that at low voltages was not admitted by Mr. Ralph D. Mershon, of New York city, he believing the contrary to be true. The fire hazard depends upon the distribution of inflammable material, more than upon the quantity. It also depends upon the provisions taken for coping with fire. Mr. Mershon is in favor of bare wiring in all places of high voltages, and for this reason objects to installing transformers in separate vaults. A perfectly fireproof wall makes wiring difficult. He thought it was dangerous to attempt draining the oil out of transformers from the bottom, and described a system recently adopted by himself, in which the oil is forced out through a pipe at the top of the case by means of water let in from below.

Mr. Mershon thinks that group switches are rather unnecessary now, as the oil-break switch has proved so reliable—more reliable, indeed, than the machinery it controls. Under some conditions he thought the air-break switch filled a need, because of the cost of the oil-break type and the complications necessary in installing it and wiring for it. If an oil-break switch could be located overhead with the wires, the conditions would be much simplified. He does not think that the marble terminal board has any place in high-voltage transformers.

Some of the difficulties in designing high-tension transformers were explained by Mr. C. E. Skinner, of Schenectady, N. Y., emphasis being laid upon the complications caused by requiring many terminals. Special bushings for high-tension terminals can not be made of wood alone, and hard rubber tubes deteriorate rapidly. Glass and porcelain are mechanically fragile, and it seems next to impossible to get moulded porcelain of sufficient dimensions for the high voltages now used. If the transformer tank is not required to withstand heavy pressures, a satisfactory construction consists of fastening a slab of insulating material, such as marble, on the top of the cast-iron cover, into which heavy tubes with sufficient extension to give the necessary surface insulation are placed. Tubes for this purpose may be made up of alternate layers of varnished paper and mica. In one instance, where the line voltage was 50,000 and the transformer case was required to withstand 100 pounds per square inch, the marble slab was omitted and extra heavy bushings were made, which passed through stuffing boxes. Oil-filled transformers should not have too high a flash test, on account of the great viscosity, which reduces the power to conduct away the heat. A well-constructed case, with a cover which is fireproof, and which can be made practically air-tight, with fireproof compartments with means for draining, will reduce the fire risk of oil-insulated transformers to a minimum.

The use of group switches is regarded by Mr. H. G. Stott, of New York, as additional insurance, and the more expensive the plant the greater is the expenditure which may be allowed for this purpose. The reliability of the oil-break switch is illustrated by the fact that in more than two years' operation of the Manhattan Railway, with 160 oil switches, no failure has occurred, although short-circuits have taken place which developed about 100,000 kilowatts. Mr. Stott emphasized the need of employing only cool-headed, reliable attendants. It is important to have highly skilled attendants on all high-tension apparatus.

Mr. P. M. Nunn, of the Telluride Electric Light and Power Company, Telluride, Col., stated that his company is now replacing all the air switches by oil switches as rapidly as possible, even in small stations, partly on account of the interruptions caused by the peculiar effects due to the air switch, and partly because air switches are not made automatic. He thought we could not afford to overlook the danger of the oil in the transformer cases. He believes that the risk is very great, and his personal experience during the last ten years has not warranted him in feeling that he can afford to overlook this risk and fail to employ all reasonable precautions, and some which eventually would be called unreasonable. This company has lost two substations—everything except the brick walls—and while there is no evidence that the fire originated in the transformers, it was the oil which caused the loss. He thinks that, in some respects, the air-blast is better, but manufacturers of transformers are not prepared to supply air-blast transformers for the higher potentials. He suggests that some one devise a transformer in which non-inflammable, non-combustible gas may be circulated in place of the air.

Mr. P. M. Lincoln, Pittsburg, Pa., thought that the risk due to air-blast transformers is greater than that due to the oil-type, because, in the latter case, the oil can not take fire unless supplied by air, while in the air-blast transformers conditions are very favorable for fire, should sufficient heat be developed at any point. He thought that the automatic damper suggested in Mr. Rice's paper could not be relied upon. When properly installed, neither the air-blast nor the oil-insulated transformer can be considered a serious fire hazard.

Mr. C. L. de Muralt said that in European practice the air-blast type is considered a greater fire risk than the oil type. The oil type heats more slowly

under overloads, which allows time for the safety devices to operate. In Europe air-cooled transformers are not generally made in sizes larger than 150 kilowatts. He thinks that the oil transformer can be made almost fireproof, and it is a good plan to put them in separate buildings, and that this need not necessarily complicate the wiring. In the case of hydroelectric plants, the building is usually long and if the switchboard is placed near the centre of the long side the transformers may be placed in the room back of it, to which the leads pass from the switchboard. Any switches needed in this room may be operated mechanically from the switchboard, and there is no need for switches on the high-tension side of the transformers. If transformers are placed in a separate building, in strong iron boxes or castings made of boiler iron riveted and caulked, strengthened by angle irons, and well covered with a tight-fitting cast-iron cover, there is absolutely no fire risk either from the inside or the outside. Mr. de Muralt described an air-break switch which resembles the Dutch horn type of lightning arrester, and which is being adopted considerably in Europe. One of these switches has successfully broken a current representing 1,500 kilowatts.

A time-limit switch was described, the action of which depends upon a relay. The circuit of the relay is closed by a small weight which is wound up by a rotating field acting upon an aluminum disc. The greater the overload, the more quickly is the switch tripped. If the overload goes off before the switch is opened, the weight returns to its original position.

Mr. O. S. Lyford, Jr., of New York city, thought that too much emphasis could not be laid upon the fact that, although transformers are fire risks, the risk is not so great that it can not be met. Transformers should be divided into three classes—oil-insulated water-cooled, oil-insulated air-cooled, and air-blast transformers. Each type fills a particular field. Thus, in a small substation where water is not available, the air-cooled type should be installed, as a blower equipment would be an unnecessary nuisance. He laid stress upon the necessity of making a station building entirely fireproof.

Mr. L. B. Stillwell, replying to the discussion, said that the auxiliary group switches for the Manhattan power station cost $2,000 a year, allowing five per cent for interest and five per cent for maintenance. This plant, during rush hours, earns $5,000 an hour, and any precaution which decreases the risk of a shutdown is advisable. It would be better to install double switches for this station, rather than have three shutdowns in the course of a year.

A number of written discussions were received, but, owing to the lateness of the hour, the meeting adjourned without their having been read.

The Case School of Applied Science.

The trustees and faculty of the Case School of Applied Science, Cleveland, Ohio, on Wednesday, May 11, will conduct the ceremonies of inauguration of Charles Sumner Howe, as president of the school. The Wednesday programme will be preceded on Tuesday, at 8 P. M., by an informal reception to the delegates at the University Club, 692 Prospect street. At 9.30 A. M. the trustees, faculty, delegates, invited guests, alumni and students will meet at the main building of the Case School of Applied Science, where the procession will be formed and will march to the Euclid Avenue Congregational Church. At 10 A. M. the inauguration exercises will begin with an address by Dr. Worcester R. Warner, representing the board of trustees. Addresses will be made by President James B. Angell, President Henry S. Pritchett, Mr. John R. Freeman, President Charles F. Thwing, and the inaugural address of President Charles S. Howe.

At 1 P. M. an informal luncheon will be served to the trustees, faculty, delegates and invited guests in the dining room of the church. From three to five the Case School laboratories and shops will be open for the inspection of delegates. At 7 P. M. the inauguration banquet will be held at the Hollenden.

The Electrical Situation in Baltimore.

The result of the Baltimore fire will be not only a large amount of electrical work in the burned-out district, but a great deal of renovation in the unaffected sections of the city. On March 17, 1902, the inspector of buildings department secured an ordinance from the city council, authorizing the inspection of electric wiring, both inside and outside of buildings. This ordinance carries with it the power of condemnation of any work not up to the requirements, and it also carries with it the right to compel the supply companies to discontinue service until such wiring has been made satisfactory. The ordinance also requires every contractor doing work, no matter how small, first to obtain a permit from the inspector of buildings department; and current can not be turned on any work until the proper certificate of inspection has been issued. This rule has been salutary in raising the general standard of the electrical work in the city.

In enforcing the above ordinance recently friction has been caused between the inspector of buildings department and the contractors. This department, while accepting, in general, the rules of the National Board of Fire Underwriters, goes further and lays down more rigid requirements, and will not approve certain lines of material approved by the underwriters. At the present time only four makes of rubber-covered wire are satisfactory to the department, though the list is subject to revision. The department's requirements for porcelain tubes and cleats are also very rigid.

In a supplement to the rules, issued in February, buildings have been classified by the department as follows: class A, residences only; class B, stores, warehouses, factories and shops; class C, public halls, apartment houses, hotels, churches and all places of public entertainment where more than one hundred people assemble at any time. The kind of work acceptable for class A includes open work, moulding, concealed knobs and tubes, and conduit. For class B, moulding work, conduit work and open work are satisfactory, and for class C, iron or steel conduit, fibrous flexible conduit moulding and open work, at the discretion of the inspector. Some comment has been made upon the fact that concealed knob and tube work is allowed in residences, but nowhere else.

The specifications for cabinet cutouts require that the construction be such as to avoid any danger of melted material coming into contact with any substance which might be ignited. The cabinets must be constructed of non-absorbent material or of wood. When wood is used the inside must be lined with slate or marble at least one-quarter of an inch in thickness, the object of this being to render the cabinet fireproof. The door of the cabinet must close against a rabbet, so as to be perfectly dustproof. Strong spring hinges and catch are required. When glass doors are used the glass must be heavy plate not less than three-sixteenths of an inch in thickness. The panes should not exceed one foot in width. A space of at least two inches must be allowed between the fuses and the door.

While, no doubt, the new requirements will raise the standard of wiring in Baltimore, it is thought that they will make the cost of this work from twenty-five to fifty per cent more than would the requirements of the underwriters alone.

The Fifth General Meeting of the American Electrochemical Society.

The fifth general meeting of the American Electrochemical Society will be held in Washington, D. C., on April 7, 8 and 9, 1904. All the sessions will be held at the Columbian University, corner Fifteenth and H streets, N. W.

On Thursday morning, April 7, a meeting of the board of directors will be held at nine o'clock. At 10 A. M. the business meeting will begin, and theoretical and experimental papers read and discussed. These will include "Standard Cells," Dr. F. A. Wolff; "The Preparation of Materials for Clark and Weston Standard Cells," Dr. H. S. Carhart and Dr. G. A. Hulett; "Single Potentials of the Halogen Elements," W. R. Mott; "The Composition and Resolution of Voltages," Dr. J. W. Richards; "Molecular Conductivity," C. J. Reed; "Remarks on Professor Richard's Theory of Heat of Neutralization, as Presented to the Society, September 17, 1903," Gustaf M. Westman; "The Energy of Ions," Dr. L. A. Parsons; "The Aluminum Electrolytic Condenser," C. I. Zimmerman.

On Thursday afternoon, at one o'clock, there will be a reception of the members at the White House by President Roosevelt. At 3 P. M. there will be a complimentary excursion to the members on a "Seeing Washington" trip to all parts of the city.

On Thursday evening, at eight o'clock, the president's address will be delivered at the Columbian University, and will be followed by a complimentary smoker.

On Friday morning, at nine o'clock, there will be reading and discussion of the following papers: "Electrolytic Iron," C. F. Burgess and Carl Hambuechen; "The Economic Balance in Electrolytic Copper Refining," Lawrence Addicks; "A New Electrolytic Separation of Gold and Silver," Herman Poole; "Observations on the Preparation of Electrolytic White Lead," C. F. Carrier, Jr.; "The Relation Between the Cost of Salt and the Cost of Power at a Given Locality, and the Resulting Cost of Electrical Bleaching Liquid Produced," Dr. W. H. Walker; "A Relative Decimal Index for Electrochemical Interests," Adolph L. Voege; "Notes on the Industrial Electrolysis of Water," Mr. W. S. Landis.

On Friday afternoon, at two o'clock, a visit will be made to the navy yard, where arrangements have been made for the members of the society to see the operation of shrinking a jacket on a modern gun. There will also be visits to the laboratories of the Bureau of Chemistry, Bureau of Standards, etc.

On Friday evening, at eight o'clock, there will be a subscription banquet at the Shoreham.

At nine o'clock Saturday morning there will be reading and discussion of the following papers: "A Contribution to the Study of the Electric Arc," Dr. William S. Weedom; "Electric Smelting Experiments for the Manufacture of Ferro-Nickel from Pyrrhotite," Mr. Ernst A. Sjostedt; "Some Experiences in Copper Precipitation," Hermann Poole; "The Relation of the Alternating Current to Osmotic Pressure," W. H. Davis; "Some Phenomena Observed in Connection with the Use of a Copper Voltameter," Isaac Adams and Barry MacNutt.

Saturday afternoon, at two o'clock, a visit will be made to the Bureau of Engraving and Printing, where special guides will be furnished. There will also be a complimentary excursion by boat to Mount Vernon.

The Place of Research in National Development.[1]

In American institutions of learning one hears, of late years, much talk concerning research and the need for its existence; and in response to this general sentiment there has developed a series of graduate schools in all our principal universities. It is not overstating the matter to say that in most respects these graduate schools, which now contain between six and seven thousand students, do not indicate any such increase in research work and in the growth of the research spirit as their numbers might imply. I am not sure that there has resulted even any definite idea as to what research is; and I am inclined to believe that the fundamental question itself, what constitutes research and what is the spirit which must exist in an individual and in an institution in order that research may flourish, is one to which American institutions need to devote themselves. Without going into a discussion of what research is, it is worth while to point out some of the difficulties which lie in the way of the development of research in our institutions, and which make it even yet a question of doubt whether our universities will ever become as efficient centres of research as those of some other countries.

The fundamental distinction which one finds in comparing our institutions with those of Europe is to be found in the difference between our elementary instruction and that given in our higher schools, universities and technical schools. The education of the European boy in the school which leads up to the university or to the technical school is simpler and more thorough, so that, when he comes into the technical school or the university, he is a better grounded man in the fundamentals of education, and he enters into an institution where, in virtue of this fact, the entire method and spirit are changed.

No one who has not been a teacher can realize how enormous is the burden thus lifted from the shoulders of the faculty and student alike. In the Institute of Technology practically one-eighth of the whole school year is given up to formal examinations. Under our system of instruction the faculty is trying to carry through the courses a considerable proportion of men who are either incompetent or who do not care for the work. American institutions are almost the only ones in any country which undertake to force into the mind of an adult man a course of instruction which he does not care to have. The great activity in research in European institutions is due, first of all, to the spirit now alive there, which makes research a test of a man's success and of his efficiency; but it is due, to no small degree, to the fact that European teachers are relieved of this enormous burden which American teachers have upon their shoulders.

Looking at the German institutions, one feels that as research institutions they have great advantages over ours in these three respects. First, because research itself is a part of the ideal of the professor's life, and the spirit of research a part, and the most vital part, of the educational spirit. Secondly, their freedom from the burden of instruction which our teachers bear, and the opportunity thus afforded to give free play to the research effort. Finally, the fixity of place and the guarantee of a retiring salary, which removes the ever-present problem of support in old age.

How important is the development of the research spirit as a part of national progress we are only just beginning to realize. We may confidently say that it will count more and more in the future in this national progress, and the problem of developing it wisely and of turning it to the solution, not alone of theoretical questions, but of practical questions of national life, is becoming each decade a more real question for civilized nations. In America we have still the intellectual habits of a pioneer people. The American is energetic, resourceful and superficial. He can make a little knowledge go farther than the citizen of any other country. Resourcefulness and nervous energy were great factors in the pioneer days, and they are great factors still; but they become relatively less effective as civilization advances.

[1] Excerpt from annual report of President Henry S. Pritchett of the Massachusetts Institute of Technology.

LOFT BUILDINGS—ELECTRIC POWER DESIRABLE.

BY E. R. KNOWLES, E. E.

The enormous growth of large cities and the concentration therein of all manner of industries have made the problem of existence a serious one for the small business man.

The large combinations of capital can very well take care of themselves, but what of the little fellow, who in some way must make a living or starve?

Take, for example, the small manufacturer, generally of some specialty, whose business depends almost entirely on a certain clientage or class of customers, all located in the city and in fairly close proximity to him, and with whom he must keep in close touch or lose their business.

The small amount of working space and limited amount of power which he requires are usually difficult of attainment in the locality in which he desires to be located. City rents are high and power costly and he can not take advantage of the cheaper and more commodious quarters obtainable outside the city limits. He must be in the city, close to his customers or quit—out of sight out of mind.

These being the conditions, we find the large cities filled with small industries, packed closely together, in all sorts of buildings and in all manner of out of the way places; generally in cramped quarters, poorly equipped with the proper amount of light, heat, ventilation and power, and working under the most adverse conditions, and yet with all that, managing to get along and even in many instances prospering and making more than a living.

The great difficulty for them is to obtain sufficient space, properly lighted, heated and ventilated, with a sufficiency of power and at a reasonable cost. The demand for such quarters is largely in excess of the supply and the rates are consequently high.

To meet these conditions the modern loft building has been gradually coming into existence, and is a growth of the necessities of the times.

As the modern office building has had its growth and has reached its maximum of development, providing small business men as well as large ones with good room, well lighted, ventilated and heated, with satisfactory elevator service and all other requirements for satisfactory business conditions and at costs which are within the reach of the smallest operator, so the modern loft building is beginning to come to the front, and to offer good and satisfactory conditions for the small manufacturer and at reasonable costs.

Heretofore all manner of business, both commercial and manufacturing, has been carried on in the same building, but now the tendency is to differentiate and to have office buildings for commercial purposes and loft buildings for manufacturing purposes, confining the different classes to its particular type of building, and even in some instances going further and having only one particular kind of industry in the building to the exclusion of all others.

The question will very naturally be asked, What is a loft building, and what is it that distinguishes it from other buildings?

By loft building is meant a building consisting of a number of floors or lofts, each floor capable of subdivision and used exclusively for manufacturing purposes, the whole building being so arranged that a number of tenants can occupy it at the same time, each having such floor space as he may require and each carrying on his special line of work independently of the others. Such buildings are usually provided with motive power on each floor, are heated and lighted, are provided with passenger and freight elevators and with such other accessories as are ordinarily necessary for the class of work and tenants which occupy them, the most distinguishing feature being the motive power supplied to all parts of the building.

Each tenant leases that portion of the building which he occupies, a certain amount of power and light being included in the lease, the heating, lighting of the public halls, ventilating and elevator service being furnished by the owner of the building.

The loft building, like the office building, is a matter of evolution and gradual growth, and while the major portion of such loft buildings as are in use at the present time are so only in name, falling far short of the requirements in many particulars, progress has been steadily made, and the more modern buildings and those recently built or under construction are fully up to the requirements for such buildings.

The main requirements for an up-to-date loft building are:

That it should be substantial and rigid in its framing, flooring and general make-up, so as to carry the weights of machinery and merchandise which may be placed in it without danger and also to withstand the shocks and vibrations due to machinery when in operation.

That it should be as near fireproof as it is possible to construct it and furnished with all safety requirements, such as fire escapes, fire hose, sprinkler systems, fire doors, double stairways enclosed in fireproof shafts, and all other devices necessary for the safety and protection of the tenants and property in case of fire occurring within the building.

That it should be extra well lighted, well heated and ventilated and provided with ample power of a character most easily subdivided according to the wants of the tenants, the power plant being located in the building and at all times under the control of the owner.

That the floors should be arranged for easy subdivision by partitions and clear from columns or posts, so as to give as great freedom as possible in the placing of machinery; the ceilings of the rooms should not be too high or too low, and should be provided with satisfactory means for attaching shafting thereto.

That it should be dry, well drained and plumbed in the best and most approved manner, and furnished with ample water and gas supplies; a live steam supply should also be provided for.

That its halls and stairways should be ample in size and well lighted; its doorways and entrances of large size, so as to afford easy means for the taking in and out of freight, machinery and other materials, and its toilet-closet facilities should be well arranged and amply large and suited to the character of the building and its uses.

That the elevators, both passenger and freight, should be of the best make and of full capacity for the uses to which they are to be put.

That the interior finish of the building should be plain and substantial and the coloring and painting light in character, no fancy work or ornamentation being necessary, everything being subordinated to the one idea of making the building as complete and serviceable as possible for the purposes for which it is to be used.

To operate such a building with maximum economy and a minimum cost for repairs and renewals, all of the apparatus and materials used should be of the best and most approved makes and installed in the latest and best manner. The first cost may be a little higher than the average, but the economical results attained will more than pay for the increased first cost.

The question of the kind and source of power to be used is a most important one. Modern usage and experience show that it should unquestionably be elec-

trical in character, as this form of power lends itself most readily to any desired subdivision and distribution with a minimum loss in transmission and transformation. By its use all of the lights as well as the machinery in the building can be operated, one common source of power only being required, and it is the only form of power which can at all times be easily and accurately measured and paid for by the consumer according to the amount used. In addition it is safe, sure, steady and certain in its action, most easily and readily controlled, and can be most economically generated.

As to the question of whether the building should be provided with its own boiler-engine-generator plant or should take its source of supply of electric current from the street service of a central electric station? experience shows that the isolated plant installed in the building and controlled by the building is the most economical and satisfactory in every way; with a properly installed plant the electric current can be generated at a less cost than it can be supplied from the central station, and it can be furnished to the tenants, even in small quantities, at much better figures than can be given by the central station service.

In addition, the large steam and hot water supplies and the heating of the building can be economically taken care of by the isolated plant, the exhaust steam from the engines being used for heating purposes.

The demand for buildings of this character is great and increasingly so, as they fill the requirements of the small manufacturer in the best and most satisfactory manner and at a reasonable cost to him.

The returns on the investment in such buildings are also large, much larger, as actual data on this subject show, than any other similar building investment, and it would seem as though this was a direction in which capitalists looking for a sure and profitable investment could operate to the very best advantage.

The Automobile as an Auxiliary for the Railroad.

The Great Western Railroad Company, of England, has established a regular service of automobiles between Slough station and Beaconsfield. The distance is about eight miles, the trip taking about one hour. The vehicles have a seating capacity for sixteen and accommodations for carrying baggage. They are equipped with a twenty-horse-power four-cylinder gasoline engine, and easily mount hills upon the road, though one of them has a grade of about six per cent.

The Annual Report of the American Telephone and Telegraph Company.

The annual report of the directors of the American Telephone and Telegraph Company to the stockholders, for the year ending December 31, 1903, has been published. This is signed by the president, Mr. Frederick P. Fish, and shows a most satisfactory condition of affairs.

The results of the business for the year 1903, as shown by the treasurer's statement appended, were as follows:

Gross revenue	$16,545,632.39
Expenses, including interest and taxes	5,980,967.30
Net revenue	10,564,665.09
Dividends paid	8,619,150.75
Carried to reserve	728,139.97
Carried to surplus	1,217,374.37

The following were the corresponding figures for the year 1902:

Gross revenue	$13,277,457.33
Expenses, including interest and taxes	5,442,185.14
Net revenue	7,835,272.19
Dividends paid	6,584,403.75
Carried to reserve	522,246.71
Carried to surplus	728,621.73

The net output of telephones during the year 1903 was 629,197, making the total number in the hands of licensees 3,779,517.

The number of exchange stations at the end of the year was 1,525,167, an increase of 247,184.

The total mileage of wire for exchange and toll service was 3,958,891 miles, of which 677,229 miles were added during the year.

Including the traffic over the long-distance lines, the daily average of toll connections was about 258,000, and of exchange connections about 9,876,000, as against corresponding figures in 1902 of 239,700 and 9,323,000: the total daily average for 1903 of connections both toll and exchange reaching 10,134,000, or at the rate of about 3,263,000,000 per year.

The total amount added to construction and real estate by all the companies constituting the system in the United States, during the year 1903, was:

For exchanges	$24,060,900
For toll lines	8,866,000
For land and buildings	2,441,800
	$35,368,700

The amount added in 1900 was $31,619,100; in 1901, $31,005,400; and in 1902, $37,336,500.

The expenditure by the company in 1903 for the construction, equipment and supplies required for its long-distance lines was $4,365,614, making the total investment in long-distance lines and equipment up to the close of the year $26,861,805.

President Fish calls attention to the development and course of the business during the year, which has been satisfactory, the returns, as indicated by the figures given, clearly meeting all reasonable expectations. In view of the general business conditions of the country, the increase in the number of subscribers and in the amount of telephone business done shows that the efforts of the company and of the companies associated with it to give a service of substantial value have been appreciated by the public. The increase in gross and net revenue and in the amount carried to reserve and surplus after the payment of interest and dividends is a satisfactory indication that the investment that has been made, and should be made from year to year to build up a comprehensive telephone system that is adequate to the needs of the community, will receive a proper return.

The necessity for developing and extending the facilities of the company, to meet the demands of the public throughout the United States, has been recognized and asserted in previous reports. The history of each year emphasizes the soundness of this policy. Not only have the specific returns from such extensions proved to be adequate, but the strength and earning capacity of the company in all parts of the country are definitely increased by such development.

Attention is called to the intelligent effort which each of the companies is making toward the improvement of service. Operating methods are being perfected and every effort being made to better the apparatus and traffic conditions in general.

Mr. Fish also emphasized the fact that many of the competing telephone companies were beginning to realize that the rates adopted by them were too low, and were seeking to raise these rates. This movement, begun only a short time ago, has been continued with force during 1903. The competing companies in almost every city of any size in which they have established exchanges have found that the cost of doing the business was far greater than was anticipated.

The matter of maintenance and depreciation is constantly before the eyes of the companies. The system of accounts, which is practically uniform for all the Bell organizations, forces them fairly to face this expense from month to month and from year to year. Before there is any question of profits, each company recognizes the necessity of reserving from its earnings such amounts as its experience has shown to be adequate to keep its property in repair, and replace it when worn out or destroyed.

The suit of the Western Union Telegraph Company against the American Bell Telephone and Telegraph Company,

which has been pending since the year 1884, and which was decided in favor of the American company by Judge Lowell, sitting as master, and by Judge Colt in the Circuit Court of the United States, has been decided adversely to the American company by the United States Circuit Court of Appeals for the First Circuit. The decision is to the effect that, under a technical reading of the contract made by the predecessor of the telephone company with the Western Union Telegraph Company and its associated companies in the year 1879, the telephone company might have to account to the Western Union company for a certain percentage of some of the stocks and bonds which it received from its licensee companies prior to 1896, when the contract expired. Every effort will be made to secure a revision of the decision of the Court of Appeals. The matter has been referred to a master, who will report as to the amount, if any, which the telephone company should pay to the Western Union Telegraph Company under the decision of the Court of Appeals, and his report, when made, will be subject to revision by the courts. It is stated that even if there should be any ultimate recovery against the telephone company, the amount will not be relatively large—certainly not enough to impose any appreciable burden on the company.

The report concludes with an expression from the directors of their appreciation of the zeal and intelligence with which the employés of the American Telephone and Telegraph Company and the officers and employés of the operating companies are cooperating to bring about the best results in the business. There is an excellent spirit throughout the organization, and everywhere a harmony of effort and aspiration which is most satisfactory. The ledger balances and comparative statement of earnings and expenses follow:

LEDGER BALANCES, DECEMBER 31, 1903.

DEBTORS.

Construction, equipment and supplies	$26,876,805.50
Telephones	6,767,189.75
Real estate	2,009,749.21
Stocks and Bonds	130,678,449.28
Patent account	173,864.35
Machinery and tools	48,126.58
Cash and deposits	13,319,533.13
Bills and accounts receivable	22,397,407.09
American Bell Telephone Company	22,110,400.00

CREDITORS.

Capital stock	$154,179,300.00
Capital stock instalments	1,972,380.00
Surplus	4,710,664.60
Bonds	28,000,000.00
Reserves	7,942,073.07
[1]Accounts payable	8,931,894.97
Contingent	18,645,210.25
	$224,381,524.89 $224,381,524.89

[1]Of this amount, $2,859,050.25 is for the dividends payable January 15, 1904, to stockholders of record December 31, 1903.

COMPARATIVE STATEMENT OF EARNINGS AND EXPENSES.

EARNINGS.

	1902.	1903.
Dividends	$6,029,523.20	$7,802,833.63
Rental of instruments	2,299,378.52	3,047,088.35
Telephone traffic	4,199,708.59	4,888,158.34
Real estate	56,030.54	73,332.15
Interest	698,816.48	734,219.92
	$13,277,457.33	$16,545,632.39

EXPENSES.

Expenses of administration	$964,827.30	$962,297.84
Legal expenses	124,645.57	95,564.60
Interest and taxes	1,970,947.99	1,993,680.08
Telephone traffic	2,381,764.28	2,929,424.78
	$5,442,185.14	$5,980,967.30
Net revenue	$7,835,272.19	$10,564,665.09
Dividends paid	6,584,403.75	8,619,150.75
Balance	$1,250,868.44	$1,945,514.34
Carried to reserves	$522,246.71	$728,139.97
Carried to surplus	728,621.73	1,217,374.37
	$1,250,868.44	$1,945,514.34

The officers of the American Telephone and Telegraph Company are Frederick P. Fish, president; Edward J. Hall, Thomas Sherwin and C. Jay French, vice-presidents; William R. Driver, treasurer; Charles Eustis Hubbard, secretary.

The directors of the company are as follows:

Charles W. Amory, George F. Baker, Francis Blake, Charles P. Bowditch, George L. Bradley, Alexander Cochrane, T. Jefferson Coolidge, Jr., W. Murray Crane, Frederick P. Fish, J. Malcolm Forbes, Henry S. Howe, Charles Eustis Hubbard, Charles E. Perkins, Thomas Sanders, Nathaniel Thayer, Theodore N. Vail, John I. Waterbury, Moses Williams.

The New General Manager of the Chesapeake & Potomac Telephone Company.

Mr. Frank H. Bethell has been elected general manager of the Chesapeake & Potomac Telephone Company, with headquarters at Washington, D. C.

Mr. Bethell will take up his new duties on April 1. Until his election he was contract agent for the New York Telephone Company. In this position he has been remarkably successful, having increased the number of subscribers during his three years of management from 70,000 to 140,000.

There has never been a more persistent advocate of the value of attractive advertising in securing new subscribers than Mr. Bethell. He made this a feature of the business of increasing the list of telephone subscribers, and made a study of presenting the multitudinous uses to which the telephone is adapted in a thoroughly convincing way.

The Chesapeake & Potomac is a well-established system and it is noted for enterprise and resourcefulness. The quick recovery and restoration of the Baltimore situation after the recent fire is an evidence of the spirit which pervades the organization. Mr. Bethell is eminently fitted for his new place, which will doubtless prove as congenial and successful as that from which he has now retired.

A RÉSUMÉ OF OUR KNOWLEDGE OF THE PHYSICAL PROPERTIES OF CURRENT-BEARING MATTER.[1]

BY DR. PAUL R. HEYL.

Any present or future hypothesis as to the nature of electricity or of electric conduction in matter must show itself capable of accounting not only for all the changes which a current produces in the matter which conducts it, but also for its failure to produce any alteration, where such is the case. It therefore becomes of interest to see what changes are produced in current-bearing matter, and in what respects the conductor remains unaltered. From this survey it is necessary to omit all reference to current-bearing gases, though much has been learned from the study of the phenomena they present, and, for brevity's sake, to confine ourselves to the probably less familiar cases of conductors and electrolytes.

We shall treat first of the length of a current-bearing conductor. The question whether there is any such change of length unaccompanied by a corresponding change in the cross-section has been considered by several persons. It will be seen at once that to distinguish such an effect in the presence of the general expansion in all directions due to the heating effect of the current is a problem of no little difficulty.

Edlund[2] heated wires by a current until they had reached a definite elongation, and estimated their temperature by means of their resistance. He found that the calculated temperature was not as great as it should have been to produce the given expansion, and concluded that there was a small elongation due to the current. His method required an accurate knowledge of the thermal coefficients of expansion and resistance, and his results were not accepted as conclusive, for the question was soon attacked anew by Streintz.[3] This experimenter brought his wires to a definite temperature both with and without a current, and compared the relative elongations. To effect this purpose he gave his wires a thin coating of stearin, heated them by a current, and noted the elongation at the instant when the stearin melted. To heat the wire without a current he enclosed it in a glass tube fitted with corks at the ends which served as an air-jacket. This tube was contained in a larger tube, and the space between them filled with stearin. A third tube enclosed the whole, and be-

[1]Reprinted from the *Journal* of the Franklin Institute, Philadelphia, March, 1904.

[2] *Pogg. Ann.*, 129, p. 15, 1866; and *Ibid*, 131, p. 337, 1867

[3] *Pogg. Ann.*, 150, p. 368, 1873.

tween the outer and middle tubes there circulated a stream of hot water by which the stearin jacket could be kept at its melting point. He made thirteen experiments, and in twelve cases there seemed to be a slight expansion due to the current, while in one case there was an apparent shortening.

Exner[1] also experimented on this question. He cooled the lower half of his wire by passing it through a glass tube full of water, and heated the cooled and the uncooled halves alternately by a current. He found that the elongation of the cooled half was only one or two per cent of that of the uncooled half; but since the stationary water-jacket and the wire it contains must both rise slightly in temperature when a current passes through the wire, this result was not conclusive.

The question was finally settled by Blondlot,[2] who by a most ingenious device succeeded in distinguishing between the thermal expansion and the suggested elongation due to the current. If a conducting sheet elongates, he says, without undergoing any corresponding increase in cross-section, any figure drawn on the surface of such a conductor will be distorted; and, in particular, an angle across which the current runs will suffer an increase in its magnitude. Blondlot used a brass ribbon thoroughly annealed. If such a ribbon be folded once over and once under, as in Fig. 1, any elongation due to the current will increase the angle ABC and cause the ends D, E to separate. This effect may be multiplied to any desired extent by folding the long end E over and D under, repeatedly, until they are again parallel as in Fig. 2, giving an arrangement which, when slightly pulled out, may be approximately described as a sort of four-sided screw propeller. If the reader will fold a strip of stiff paper in this manner he will find a series of angles so joined that if each suffers a slight increase the effect is cumulative, and there is a twist in the whole spiral. Blondlot folded his ribbon into 200 such angles, arranged it in a vertical position with one end soldered to a conducting support and the lower end dipping into mercury. A small mirror was affixed to the lower part. By observing from a distance the image of a scale reflected in this mirror the smallest twist could be detected. He used a current density of 370 amperes per square centimetre, and found that when the ribbon was carefully annealed there was no perceptible twist. He says he could have detected an elongation of 0.00025 millimetre. He does not state the length of his ribbon, but from the fact that he was able to fold it 200 times it must have been in the neighborhood of a metre long. Imperfect annealing or poor soldering of the upper contact produced a slow twist in the wire which disappeared slowly when the current was stopped. This was evidently due to unequal heating, and serves to show the extreme delicacy of the method. The existence of an elongation or contraction unaccompanied by a proportional change in cross-section thus seems to be definitely disproved. The question of a change in volume by expansion in all directions, or (what amounts to the same thing) a change in the thermal coefficient of expansion due to the current, is left still open.

We shall next consider the elasticity of a current-bearing conductor. Wertheim[1] tested this in two ways, by Young's

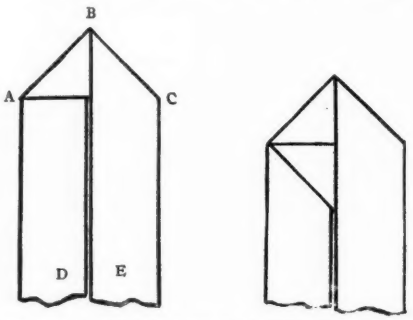


FIG. 1.—FOLDED METAL RIBBON IN TESTS FOR ELONGATION.

modulus, and by the note produced by a vibrating wire, and found apparently a small diminution in the elasticity. He seems to have taken no precautions to eliminate or allow for the heating effect of the current other than remarking that the fall in pitch in the case of the vibrating wire could not have been caused by the heating, else the note would have risen slowly when the current was stopped, whereas it rose rapidly. A sample result on a vibrating wire is this: a copper wire, diameter 0.59 millimetre, gave 1,058 vibrations per second without a current, and 1,041 with a current of 7.8 units. Later investigations have shown that Wertheim's results are undoubtedly untrustworthy.

Streintz[2] experimented on the modulus of torsion, using stearin-covered wires, as in his length experiments. He found the time of vibration to be the same, whether the wire was heated with or without a current. He supposed at that time, from his length experiments, that allowance must be made for the current elongation, which would show a small change in the modulus; but as it is now known that no such elongation exists, his results are really negative.

Mary C. Noyes[1] investigated Young's modulus. At first she thought that there was an irregular effect, varying with the history of the wire, such as the number of times it had been heated or had carried a current. In her second paper she adopted the method of measuring the temperature of the wire by its elongation. Apparently unaware of Blondlot's results, she remarks that some experimenters have found small changes in length due to the current, but that these were negligible. Measuring on this basis, which is probably entirely accurate, she found no perceptible effect on Young's modulus other than that due to the accompanying heating effect of the current.

The next property to be considered is cohesion. Peltier[2] sent currents through wires of copper and iron for from four to nineteen and one-quarter days, afterward breaking them while no current was passing. It appeared as if copper was weakened by this treatment and iron strengthened. There are several objections to be urged in this connection, chiefly the long continued thermal effect, and the fact that pieces of wire cut from the same spool may vary several per cent in tensile strength. The latter difficulty can be eliminated only by a large number of systematic observations.

Wertheim[3] broke wires while the current was passing, and found that gold was apparently weakened about forty per cent. He seems to have broken one such wire with the current and one without it. In a few experiments on iron and steel he found changes sometimes one way and sometimes the other, of the order of two to ten per cent.

The present writer has some experiments on this question in progress. They are not yet ready for publication; but, so far as he has yet gone, his results are negative.

It has always been assumed, without any definite experimental evidence, that the weight of a current-bearing conductor is unaltered. The writer suggests that this is hardly scientific, but savors rather of the older deductive philosophy. Faraday thought it worth while to test the question, but he was led in the course of his experiment to a new discovery,

[1] *Nature*, 13, p. 452; also Wiedemann, *Lehre von der Electricität*, vol. ii, p. 409, where further references to original papers are given.
[2] *Comptes Rendus*, 87, p. 206, 1878.

[1] *Ann. de Chim. et de Phys.*, 1844 [3], 12, p. 610.
[2] *Progg. Ann.*, 150, p. 368, 1873.

[1] *Physical Review*, 2, p. 277, 1895, and 3, p. 432, 1896.
[2] *Comptes Rendus*, 20, p. 62, 1845.
[3] *Ann de Chim. et de Phys.*, 1844 [3], 12, p. 610.

and never pushed his work to a definite conclusion. This will be referred to later. But while there seems to be no direct experimental evidence on this point, there is indirect evidence to show that there is no change in weight (at least, in copper wires) to the extent of about one part in 1,000. This evidence is furnished by work that has been done with the current balance.

It is interesting to notice that the first person to use a current balance (Cazin in 1864)[1] seems never to have thought that there was a possibility of the weight altering when a current passed, as his original paper is silent on this point. In this he was followed by greater names (Joule, Helmholtz). That this question was considered by Faraday, even if he reached no conclusion, serves only to add to his reputation as an exponent of inductive methods in science.

Probably the best work on the current balance is that of Lord Rayleigh and Mrs. Sidgwick on the electrochemical equivalent of silver.[2] Their value for this constant is 0.00111794. Fr. and W. Kohlrausch[3] determined the same, measuring the current against the earth's field by an accurate tangent galvanometer. Their value is 0.0011183. Patterson and Guthe[4] measured the current against torsion, determining the latter by time of swing and calculated moment of inertia. Their value is 0.0011192. The close agreement of the first of these figures with the two others shows that no serious error could have been introduced by the assumption that the weight of a current-bearing conductor remains unaltered. In pronouncing this effect negative it must be borne in mind that the current density in the coils of the current balance must be quite small, in order that thermal disturbances may be avoided. It would be an interesting though difficult research to determine what effect, if any, a heavy current has on the weight of the conductor. Any one contemplating such a research will find a useful suggestion on the weighing of hot bodies in a paper by the present writer in the *Journal* of the Franklin Institute for May, 1898.

Let us next consider the electrical resistance of a conductor. As the question of there being any resistance when there is no current flowing is rather a metaphysical one it will not be discussed here, but we shall limit ourselves to the effect produced on the resistance when the current changes from a vanishingly small magnitude to a very great one. The question may be put in this way: is Ohm's law accurate, or is the ratio $\frac{E}{C}$ not a constant, but a function of the current? Schuster, in England, believed that some results of his with a sine inductor pointed to the conclusion that Ohm's law was inaccurate, and the British association appointed a committee, of which Maxwell was a member, to test the question. Their report[1] describes two methods of experimenting, the theory of which is due to Maxwell, while the actual experiments were performed by Chrystal. In the first method five coils of nearly equal resistance (about thirty ohms) were employed. Their ratios were carefully measured, and it was found that this could be done to about one part in 4,000,000. If two of these coils be balanced against each other in a Wheatstone's bridge, the coils occupying the two lower sides of a quadrilateral diagram, the current strength in the coils will be equal when there is no current through the galvanometer. Now replace one of these coils by a set of four, arranged two in series and two in parallel, and when no current flows through the galvanometer the current strength in each coil of this set will be one-half that in the single coil in the other arm of the bridge. Consequently, if the resistance be a function of the current strength, the single coil will not balance the set of four. In carrying out this method it seemed that there was a falling off in the resistance of about one part in 200,000 when the current was doubled in strength; but a large part of this was afterward found to be due to defective insulation. As for the rest, the results of the second method make it certain that it must be attributed to some unrecognized error of experiment.

The theory of the second method is developed mathematically by Maxwell in the "report" already referred to. He shows that if there be two conductors of the same material and different cross-sections arranged in series and carrying the same current, any departure from Ohm's law will be greatest in the conductor of smaller section, and if their resistances be equal for small currents they will not be equal for large ones. The ratio of their resistances is expressed by the following formula:

$$\frac{L_1}{A_1}\ \frac{A_2}{L_2}\left\{1 + s\,C^2\left(\frac{1}{A_1^2} - \frac{1}{A_2^2}\right) + \ldots.\right\}$$

wherein L_1 and L_2 are the lengths, A_1 and A_2 the sectional areas of the two conductors, C the current in both, and s the coefficient of departure from Ohm's law, which is zero if the resistance does not vary with the current. It will be seen from this formula that (neglecting some small higher terms) the resistances may vary and their ratio remain constant, provided their areas are the same. Consequently the two wires chosen were made to differ greatly in area, and their resistances were made about equal by having the fine one short and the coarse one long. These wires were joined in series as two arms of a Wheatstone's bridge and a heavy and a weak current were sent through them in rapid succession (about sixty times a second) by means of a tuning fork. This served to eliminate the heating effect, or, rather, to keep the wires at a constant temperature for both currents, as the wire had not time to cool during the passage of the weak current before the heavy one had returned. A balance was obtained with this intermittent current, and the weak current was then reversed in direction, the stronger remaining unaltered. The balance remained undisturbed. This could only have taken place if the resistances were independent of the current; for if the resistances varied no true balance could have been obtained in the first place, and what appeared to be a balance would have been merely a stationary needle under the influence of a rapidly alternating current, which would be converted into a direct (though fluctuating) current upon the reversal of the weak current before mentioned. As a result of this method the committee was able to state that when the current varied from a vanishingly small value up to one ampere per square centimetre the resistance did not vary by as much as one part in a million million!

There are few laws in physics whose verification has been pushed as far as this. In this case the natural limit of the solid continuity of the conductor was almost reached, as the strong current heated the fine wire beyond redness. This is the more remarkable, as Ohm's law was originally entirely empirical, without any theoretical reason to render it probable.

There are two substances, mercury and carbon, whose specific heats are known not to vary appreciably when a current is passed through them. For mercury this follows as a corollary to the work of Barnes and Cooke[1] with the continuous flow electrical calorimeter. In this in-

[1] *Ann. de Chem. et de Phys.*, 1884 [4], 1, p. 257.

[2] *Phil. Trans.* [2], 411, 1884; and *Proc. Royal Soc.*, 37, 144, 1884. Also Rayleigh's *Collected Papers.*

[3] *Wied. Annalen*, 27, 1, 1886.

[4] *Physical Review*, 7, p. 257, 1898.

[1] *B. A. Report*, 1876, p. 36.

[1] *Physical Review*, February, 1903.

strument a slender thread of mercury was heated by the passage of a current and the results agree with the best results of earlier methods to about one part in 300.[1] For carbon the writer has shown[2] that the specific heat is not altered by one part in 450 for a current density of about 150 amperes per square centimetre. His method depended on the fact that a small abrupt change of temperature might be expected if the specific heat changed suddenly when the current was started or stopped.

So far, all the effects of the current upon the properties of the conductor have been negative. There are a few positive effects. These are the well-known magnetic effect discovered by Oersted and amplified by Ampère; the three heating effects known by the names of Joule, Peltier and Thomson, respectively, and an alteration of the surface tension of a liquid conductor discovered by Faraday.[3] The latter was attempting an experiment on the weight of a current-bearing conductor, and had suspended a coil beneath a scale pan with one free end dipping into mercury. On starting the current the coil became much lighter, which Faraday found to be caused by the fact that the mercury was not so strongly drawn up around the wire when a current was passing.

There may also be an alteration in friction between two surfaces across which a current passes, as in Edison's motograph or chalk-cylinder telephone receiver. In this instrument a palladium surface rests upon a cylinder of chalk which has been soaked in a solution of sodium phosphate, and which is kept slightly moist and continuously rotated. When a current passes the palladium slips more freely over the chalk. An electrolytic explanation has been offered for this phenomenon, which supposes that gases developed in the solution carried by the chalk are occluded by the palladium. In favor of this there is the well-known property possessed by palladium for occluding hydrogen, and against it the fact that the instrument works best in the secondary circuit of an induction coil; also against it is the fact that the action is reversible, and a "motograph battery" has been constructed in which the friction of the palladium against the revolving chalk produced a current.

Passing now to the properties of current-bearing electrolytes, it has been shown by Faraday[1] that such a liquid has no effect on polarized light when the latter passes either across the current or in the same line with it. The electrolytes used were saturated solutions of sodium sulphate and lead nitrate.

Roiti,[2] Zecher[3] and Rayleigh[4] have investigated the speed of light in a current-bearing electrolyte with negative results. Zecher's paper the writer has not yet seen, as there is no copy of it in the Philadelphia libraries; but as Rayleigh remarks that his own work has been pushed farther than either of the others, it will be sufficient to consider his results. He used an interference method, employing dilute sulphuric acid and a current density of 0.26 ampere per square centimetre. He showed that for a current density of one ampere per square centimetre there could be no effect as great as one part in 13,000,000. He remarks that this result could be pushed somewhat further if there was any reason to expect an effect of that magnitude; but from the fact that the speed of light is 3×10^{10} centimetres per second and that the swiftest ion (hydrogen) urged by a fall of potential of one volt per centimetre is about ten centimetres per hour, the light wave could hardly be expected to know that the ions were in motion, the ratio of the speeds being something like one to ten million million.

Gladstone and others have shown[5] that a current accelerates lagging chemical reactions, such as the precipitation of potassium acid tatrate and strontium sulphate; and Barus[6] finds that it also promotes the settling of suspended matter.

Mills[7] and Bouty[8] have shown that metals may be electrically deposited in films under tension or the reverse by properly choosing the current strength; and the latter finds that in the electrolysis of a number of salts ($CuSO_4$, $ZnSO_4$, etc.), a current strength may be found, so that for greater currents the negative electrode is warmed, and for less cooled by the separation of the metals. For the same salts may also be found a limiting current strength, so that beyond it the separated metal exerts a pressure, and below it a pull upon that on which it is deposited. Moreover, these two neutral points are not identical for the same solution.

The present writer has shown[1] that crystals formed from a current-bearing electrolyte are not affected by the current, though they may be somewhat distorted by the accompanying heating effect in the liquid.

The foregoing seem to be all the properties of current-bearing solids and liquids that have been investigated. If any reader can supplement this bibliography, the writer would consider it a favor if he would do so, addressing him at the Central High School, Philadelphia. After reviewing what has been done in this field, many interesting research problems are suggested. Some of this work the writer has under way, and it would be well for intending workers in this field to correspond with him in order that useless duplication may be avoided.

[1] *Science*, July 10, 1903.
[2] Vol. clvii, No. 939.
[3] *Experimental Researches*, 2, p. 256.

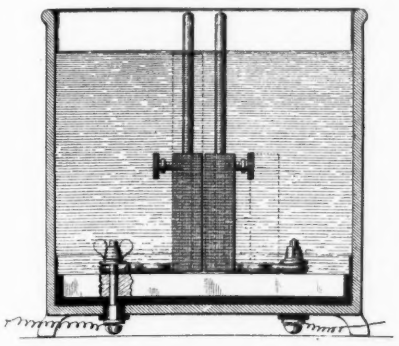
[1] *Experimental Researches*, 1, p. 285, § 951 *et seq.*
[2] *Pogg. Ann.*, 150, p. 164.
[3] *Repertorium der Physik*, 20, p. 151, 1884.
[4] *B. A. Report*, 1888, pp. 339-360.
[5] *B. A. Report*, 1887, p. 667; also *Nature*, 36, 524.
[6] *Bulletin U. S. Geological Survey* No. 36.
[7] *Proc. Roy. Soc.*, 26, No. 184, p. 504, 1877-78.
[8] *Comptes Rendus*, 92, pp. 868-870, 1881.

Electrical Patents.

An electrical water heater is the subject of a patent recently obtained by Mr. Harry M. Hill, of St. Louis, Mo., who has assigned the same to the Hill Electrical Manufacturing Company, of the same place. In the invention electrode supports are employed, each of which comprises a base resting upon the porcelain base of the receptacle and having a longitudinal slot in which a bolt is received, so that each support can be adjusted toward and away from the coacting support, while vertical standards, rising from the base, pass through suitable openings in the electrode. Set-screws seated in the electrode engage the standards, and thus serve to hold the electrodes in vertically adjusted positions upon the standards. Each support is formed of a single piece of wire, whose free ends form the standards, and the portion between the standards extends at an angle to them to form the base. This base comprises side bars, each of which has one end connected to one of the standards, by a portion which is first bent outwardly to produce a guide projection. Between these side bars are intermediate bars, which are spaced from each other to produce the above-mentioned slot and are connected at their inner ends; *i. e.*, the ends toward the standards, the outer end of each intermediate bar being connected to the adjacent side bar by a transverse connector. Conducting wires

[1] *Physical Review*, 15, No. 6, December, 1902.

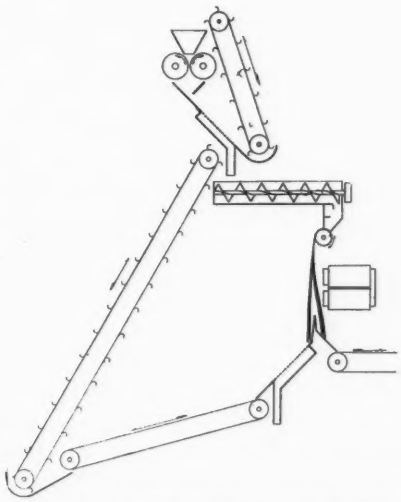
forming a suitable source of electrical energy are connected to the binding-posts, and the electrode supports have their bases placed between the base and the set-nuts, the electrodes being placed upon the standards with the standards passing through the openings provided for them in the electrodes. Water enters the space between the electrodes, and being heated from the current passing from one to the



ELECTRICAL WATER HEATER.

other thereof rises, the colder water flowing into the lower portion of the space between the electrodes to take the place of the rising heated water and the circulation being thus maintained. Manifestly the extent to which the water is heated during a single passage between the electrodes is dependent upon the effective conducting surfaces of the electrodes. If the electrodes have the whole of their surfaces in opposition to each other, current passes from one electrode to the other from the whole surface of each electrode and a relatively great amount of heat is imparted to a column of water flowing between the electrodes. If, however, one of the electrodes be moved across the opposing face of the other to occupy the position in which the left-hand electrode is situated, the opposing or effective surfaces of the electrodes are reduced, so that a smaller amount of heat is transmitted to the column of water flowing between the electrodes. Should one of the electrodes be moved entirely out of line with the other, the whole current is cut off. The degree of heat imparted to the water can therefore be regulated at will, the electrodes being held in their adjusted positions by means of the set-screws.

Thomas A. Edison, of Llewellyn Park, N. J., has recently invented an improved process of separating ores from magnetic gangue. It has been heretofore proposed to treat the nickeliferous ores by subjecting the magnetic pyrrhotite and non-magnetic nickel compound to the action of a magnetic separator for the purpose of separating the magnetic from the non-magnetic portions. Owing to the fact that with some nickeliferous ores the non-magnetic nickel sulphide or other nickel compound occurs in very small proportions admixed with practically pure pyrrhotite, it is found that the ordinary magnetic separation of such ores is not perfect as is desirable, for the reason that the relatively large mass of magnetic particles tend to form clots which coalesce together by magnetic induction and entrap the non-magnetic particles which are therefore carried over into the concentrate or gangue with the magnetic particles. The same objection is present when the attempt is made to treat by any known magnetic separating process any other ore having a relatively large proportion of magnetic material, such as pyrrhotite carrying small proportions of copper pyrites. The object of the present invention is to provide an improved process by means of which a very perfect separation of the magnetic and non-magnetic particles can be effected in connection with any ores where the proportion of the non-magnetic material is very low. The process is as follows: the ore—composed, for example, of pyrrhotite and nickel sulphide or other compound—is first reduced by grinding to a condition of fineness, de-



PROCESS OF SEPARATING ORES FROM MAGNETIC GANGUE.

pendent to a certain extent upon the character of the material being treated; but for ordinary purposes the reduction of the material to particles which pass through a screen having four meshes per linear millimetre will give satisfactory results. In any event the screening of the material should be carried to a sufficient degree of fineness as to practically isolate the magnetic and non-magnetic particles. To the ground material is now added a much larger bulk of a coarser non-magnetic material, preferably quartz sand. When the material being treated has been so reduced that the largest particles are not larger than one-fourth of a millimetre in diameter, the coarser material should be composed of particles about one-third of a millimetre in diameter. This same proportion may be observed when the material to be treated has been reduced to other conditions of fineness. The proportion of coarser material may vary from two to seven times the bulk of the latter. The pyrrhotite, nickel sulphide, or other nickel compound and added coarser material are intimately mixed together and passed through a suitable magnetic separating apparatus. Owing to the presence of the added coarser material, the magnetic particles are separated and prevented from coalescing under the effect of magnetic induction, but are drawn directly out of the mass by the magnetic attraction, and do not entrap the non-magnetic particles, and in consequence practically all of the nickel, copper, or other metal or metallic compound is recovered in the tailings. These tailings, which are rejected by the magnetic separator, are composed of the non-magnetic added material, such as quartz sand and the nickel sulphide or other nickel compound or copper pyrites, etc. These two materials can now be effectively separated by screening, owing to their difference in size, and the quartz sand or other added material can be used over and over again in facilitating other separating operations.

Massachusetts Institute of Technology.

The thirty-ninth annual catalogue of the Massachusetts Institute of Technology describes the thirteen distinct undergraduate courses in engineering and science which are there offered. In electrical engineering there is the usual four-year undergraduate course. There is also a graduate course of one year, leading to the degree of master of science, and a two-year course in the graduate school of engineering research which leads to the degree of doctor of engineering. The register of students shows that there are now 1,528 at the institute.

The annual report of the president and treasurer describes the progress made during the past year, and shows that a number of legacies and gifts have been received. Those devoted to electrical engineering bring the aggregate for this purpose up to $68,000.

Reviews of Current Engineering and Scientific Literature.

Apparatus for the Simultaneous Detection of the Absorption of the α and β-Rays of Radium.

In this article Herr F. Pachen describes an apparatus for simultaneously observing the absorption of the α and β-rays given off from radium. An exhausted glass vessel containing the radium salt has fused into it a spiral platinum wire. This is surrounded by, but separated from, a lead cylinder. The whole is contained within a glass vessel, the lead cylinder and the glass tube being suspended from quartz rods. To the platinum wire is attached a gold-leaf electroscope, a similar electroscope being suspended from the lead cylinder. In this apparatus it is noticed upon exhausting the vessel that each electroscope diverges, showing charges of electricity. Upon bringing up an electrified glass body, the divergence of the electroscope attached to the platinum wire increases, that of the other decreasing, showing that the former is positively electrified and the latter negatively. After standing for some time, the two diverging leaves may come into contact, and the charge will be neutralized; but since the positive charge is greater than the negative, the two electroscopes will remain slightly positively charged. This fact is also indicated by the unequal divergence of the two electroscopes, that of the one attached to the platinum wire being always the greater. This is due to the imperfect absorption of the lead cylinder.—*Translated and Abstracted from the Physikalische Zeitschrift (Leipsic), March* 15.

M. Blondlot's N-Ray Experiments.

In this communication M. R. Blondlot replies to those who have not been able to repeat his experiments. On January 14 several distinguished French scientists went to Nancy and witnessed the experiments there. They saw and repeated them themselves, and they also determined the deviations of the N-rays by a prism of aluminum, and the focusing of them by an aluminum lens. They observed the fringes produced by gratings and Newton's rings, and photographs were also taken showing the effect of these rings. Later M. Blondlot was visited by Becquerel, as well as by a number of English scientists, who also observed the phenomena. The author does not believe that the effect can be attributed to heat, and he states that he has not published a single experiment which has not been repeated by several colleagues and also by persons not acquainted with scientific research work. He recommends that other physicists desirous of studying the subject take every precaution to eliminate disturbing influences—particularly with regard to heat—by interposing several layers of wood, aluminum and cardboard, with large surfaces and separated from each other by air. A screen of moistened cardboard should be interposed near to the source, and away from the sensitive screen. Although the actions of the N-rays require delicate methods to be observed, the author has encountered only three or four persons out of a great number who were not able to detect them.—*Abstracted from the Electrician (London), March* 11.

The Electricity Works and Destructor of the Metropolitan Borough of Hackney, England.

A description is here given of the power station and refuse destructor of the borough of Hackney. In 1898 a report was made by a consulting engineer, recommending that about $1,250,000 be set aside as an initial outlay for establishing an electric lighting plant. Of this, the sum of $110,000 was allotted to the installation of a refuse destructor capable of dealing with 38,000 tons per annum. The plant was completed and put into service in November, 1901. The electrical equipment presents no particular interest. It supplies at 240 volts, direct current. The plant is capable of handling 75,000 eight-candle-power incandescent lamps. The refuse destructor consists of twelve cells, in three groups of four each. The refuse is brought in in horse-drawn carts up inclines to the tipping floor. From here it is run down through chutes to the drying floor and then raked forward into the cells. The gases from each group of cells are passed to a water-tube boiler having 2,852 square feet of heating surface and rated at 10,000 pounds of water per hour when fired by coal. Each group of four destructors was designed to deal with sixty tons of refuse per day, although they have destroyed a total of nearly 190 tons on occasion, and the average last year was 120 tons. They are shut down for twenty-four hours on Sunday. A by-pass is provided, enabling the gases to be carried directly to the chimney without passing under the boilers. In either case they pass through a whirling chamber, where the dust is removed. They are then passed through economizers. In addition to these three boilers, the station has four others of the same size which burn coal only.—*Abstracted from the Electrical Review (London), March* 11.

Gas Explosions.

Part of the work on gas explosions by Dugald Clerk and Grover was to determine the effect of the products of combustion on the next explosion. Grover found that with mixtures of coal gas and air in which the volume of coal gas is less than one-eleventh of the whole volume, there is an advantage in replacing some of the excess air by the products of the previous explosion. Above one-eleventh, the effect of the addition of burned products in small proportion is to give a very slight increase of pressure. A larger proportion is decidedly prejudicial to the maximum pressure. In this article Mr. L. Bairstow gives the results of a study of this effect which he has carried out. Gas of constant composition was used, but an ignition arrangement was employed. In this four spark-gaps were caused along the axis of the experimental cylinder, in place of the one used by previous experiments. With this arrangement a remarkable change was found when the volume of the gas was about 0.086 of the total volume of the cylinder. With the richest mixture—that in which the volume of the gas is about one-eighth of the whole volume—the pressure curve of the explosion is very sharp on each side of the maximum. When the amount of gas is about one-tenth of the maximum, the pressure curve shows signs of flattening, which is still more obvious with a richness of about one-ninth. The curve continues to flatten until the richness is about one-twentieth, when the line is nearly horizontal and the maximum pressure is but little more than the initial. In all cases sufficient air was admitted to burn the gas completely. From these curves a curve showing the loss of volume after combustion was plotted, and it was found that this is practically a straight line directed toward the origin until a point is reached at which the combustion is incomplete, when there is a sudden drop and the slope of the line is changed. It

was thought that this indicates that Grover's results were due to incomplete combustion of the gases and that the addition of burned products is equivalent to the addition of gas.—*Abstracted from Engineering (London), March* 11.

Parallel Operation of Alternators.

When alternators are operated together it is necessary not only that they should be of the same type and give the same voltage at the same frequency, but that they should run together synchronously. It is also necessary that the angular velocity of the several machines should be fairly constant. If there is an angular variation in speed a cross current will flow between the machines, which will tend to bring them back into step. When the alternators are driven by independent prime movers, this action is all that is necessary, if the angular variation be not too great; but when two or more machines are driven from one line shaft or engine, readjustment can take place but slowly, since the relative velocities of the driving wheels can not be changed, and the machines can be brought back into step only by causing one belt to slip. For this reason it is inadvisable usually to attempt to drive more than one alternator from the same shaft, but in some cases this seems to be necessary. Such an instance would occur when a water-wheel driving a mill is used also to drive a dynamo for lighting, and when the lighting load increases so that it becomes necessary to add a second machine. In this article Herr J. G. Köhler suggests a method for quickly readjusting the two machines driven from the same line shaft, but which have run out of exact synchronism. One of the generators is driven from a pulley which is slightly conical, and by means of a lever the belt upon this can be shifted so as to change the speed of that generator. The position of this lever is controlled by a small direct-current motor driven from the exciting circuit. This motor is, in turn, controlled by a relay which is connected in a circuit between the corresponding poles of the two alternators. When these machines run out of synchronism, part of the cross current will flow through this circuit and will throw the relay one way or the other, causing the regulating motor to shift the belt on the conical pulley until the two generators are exactly in phase again. The relay consists of a small motor with a single coil oscillating armature, which, by means of two arms, connects the regulating motor one way or the other with the exciting circuit. The author shows that the field of this relay is excited from the exciter circuit, but it is evident that this arrangement would not be operative. The field should be excited from the generator bus-bars.—*Translated and abstracted from the Elektrotechnischer Anzeiger (Berlin), March* 6.

Roentgen Rays and the γ-Rays from Radium.

It has been shown by Mr. Strutt that the relative conductivity of gases, due to the γ-rays of radium, varies approximately as the density, whereas the conductivity due to Rœntgen rays shows no such relation. This fact suggested comparative experiments to ascertain if the more penetrating Rœntgen rays—those which passed through thick metal screens—are similar in their action to the γ-rays of radium. This work has been done by Mr. A. S. Eve, who finds that the relative conductivity imparted to gases by the Rœntgen rays is a function of the penetrating power of the rays employed, and the results obtained approximate to those found for the γ-rays, rather than to the high figures previously quoted for Rœntgen rays. The results so far obtained indicate that the differences in the relative conductivity of gases previously observed for the two kinds of rays were due to the great difference in the penetrating power of the rays, and that for Rœntgen rays comparable in penetrating power with the γ-rays. these differences, to a large extent, disappear. Commenting upon the above work, Mr. E. Rutherford, in a communication entitled "Nature of the γ-Rays and Radium," says that this work removed the strongest objection that has been urged against the common belief that the γ-rays are an extremely penetrating type of Rœntgen rays. All experimental evidence so far obtained is in agreement with the view that the γ-rays are very penetrating Rœntgen rays which have their source in the atom of the radioactive substance at the moment of the expulsion of the β particle. It has been shown that these rays always accompany the β-rays, and are proportional in amount to them. The fact that the amount of γ-rays from radium is independent of its degree of concentration, points to the conclusion that the γ-rays arise from the disintegrated atom, and are not secondary rays set up by the bombardment of the radium as a whole by the β-rays. According to the theory of Stokes and Thomson, it is to be expected that Rœntgen rays would be set up at the sudden starting, as well as at the sudden stopping, of the electron or β particle. As a result of the sudden expulsion of the particle from radium, it is to be expected that a narrow electromagnetic pulse—that is, hard or penetrating Rœntgen rays—would be generated; and, in addition, on account of the great speed of the β particle, it is able to penetrate through a considerable thickness of matter before it is stopped. A broad pulse, or soft Rœntgen rays, should thus arise at points of incidence of the β-rays.—*Abstracted from Nature (London), March* 10.

Methods of Regulating the Speed of Continuous-Current Motors.

In this paper M. Brunswick describes the various well-known methods of controlling the speed of continuous-current motors, giving what he considers to be the defects of each method. He then takes up the Lanhoffer method, which comes in the class in which the speed is controlled by varying the magnetic flux. In this system there is one long armature consisting of two independent cores with but one winding and surrounded by two independent fields. The excitation of one field is maintained constant; that of the other is varied at will and can be reversed. The resultant effect is due to the sum or the difference of the two field strengths. Figures are given to show that this method is efficient. A motor at constant power, operating at speeds varying from 300 to 2,000 revolutions per minute, varies but slightly in efficiency. The same is true of this motor when operating under a constant torque; the speed may be varied at will, with but slight change in the efficiency. The author then describes the Boucherot system. In this four dynamos are connected up somewhat in the same manner as the Wheatstone bridge, those diagonally opposite being excited in the same sense, but each pair opposing the other. It is shown that a constant potential may be maintained between two points of this system, corresponding to the battery connections of a Wheatstone bridge, and that from the points corresponding to the galvanometer connections a current may be drawn which is independent of the voltage between the latter points and of the resistance of that circuit. This current will be equal to the constant voltage mentioned above, divided by a constant, and by varying the latter, which can be done by varying the field excitation, any current may be obtained. Placing a series motor in this position enables it to run at any speed with constant torque; or, by varying the constant, the speed and torque are controlled at will. —*Translated and abstracted from the Bulletin de la Société Internationale des Électriciens (Paris), February.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Oil Car Circuit-Breakers.

The use of circuit-breakers as a means of protecting the car equipment from dangerous overloads has become quite general and has led to the development of several different types of breakers designed especially for this class of service.

The oil car circuit-breaker herewith shown, manufactured by the Hartman Circuit-Breaker Company, of Mansfield, Ohio, is designed to take the place of the fuse-block and hood switch on the car. It automatically opens the circuit in case of overload or short-circuit and can be readily operated by hand.

The switch and current-carrying parts are immersed in oil within a tight cast-iron case. The feature of oil insulation permits of more compact and simple construction than is possible with the usual magnetic blowout type. The distinctive feature of the circuit-breaker, however, is the use of a series break, consisting of five double-break plug contacts connected in such manner as to give ten breaks in series. The circuit is broken simultaneously at ten distinct points, and the break taking place in oil there is no destructive arcing and the circuit-breaker will open quickly and safely on the severest overloads.

The operating mechanism is simple and

OIL CAR CIRCUIT-BREAKER.

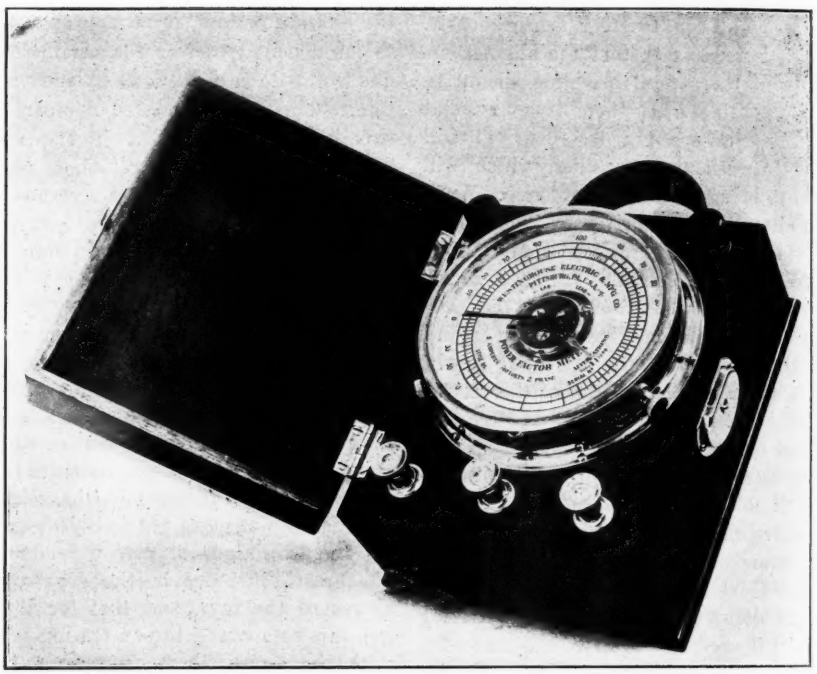
consists of a vertical rod, to the lower end of which are attached the movable bridging contacts. The rod operates in a brass bearing and is controlled by a toggle. A slight turn of the handle will cause the toggle to straighten out, thus raising the contact rod and effecting the closing and locking of the switch. The tripping coil is immersed in oil within the case, and, when an overload occurs, the plunger or core operating within the brass tube of the solenoid delivers a strong hammer blow against an extension of the lower joint of the toggle, throwing the toggle out of centre and effecting the opening of the switch.

Ample space is provided between the live parts of the switch and the cast-iron case, and, as an additional precaution against grounding, the case is lined with insulating cement. Connection to the outside circuit is made within the case by means of insulated cables.

While the circuit-breaker was primarily designed for car service it is also well adapted for switchboard use. It is usually placed on the back of the panel with the handle rod projecting through the board, and the circuit-breaker is opened or closed by hand from the front of the board. The circuit-breaker is also especially well adapted for the protection of motors in mills and factories, for the reason that it is not affected by damp and dirty locations, and there being no exposed current-carrying parts the circuit-breaker is never a source of danger to those who may be working in the vicinity.

A New Portable Power-Factor Meter.

It has been found possible to avoid errors and to simplify the process of determining the power-factor of a polyphase circuit by employing a single instrument



PORTABLE POWER-FACTOR METER.

which indicates directly upon a scale the power-factor of a circuit, reproducing on the dial, by the position of a pointer, the angle of phase difference, and giving the actual power in percentage of the apparent power. Such an instrument made in suitable form for testing purposes is shown in the accompanying illustration of the new portable power-factor meter made by the Westinghouse Electric and Manufacturing Company, Pittsburg, Pa. It operates with equal facility and accuracy on either a leading or lagging current, and indicates whether the current leads or lags, whether power is delivered to or by the circuit, and the power-factor.

In principle, it consists of two sets of coils, one of which contains a separate series winding for each of the phases in the circuit and the other a potential winding which is connected across one phase of the circuit. The series coils are so arranged as to produce a resultant rotating field. A small iron vane, passing through the potential winding, forms movable pole-pieces for this winding, which takes

up a position in the rotating field, depending upon the phase relation of the currents producing this field and the voltage impressed upon the potential winding. The pointer attached to the shaft carrying the movable vane indicates on a scale the angle between the current and the voltage, the scale being so graduated as to read directly in power-factor. Should the power-factor of the different phases differ from each other, the instrument will indicate the average power-factor.

Different instruments are provided for two and three-phase circuits. They are made with the same care and accuracy that are employed in the manufacture of the other Westinghouse testing instruments, are finely finished and provided with covers which are made removable for convenience in use.

H-P Cable Hangers.

The accompanying illustration shows the new form of H-P cable hanger manufactured by James S. Barron & Company, West Broadway and Franklin street, New York city. This cable hanger is made of one piece, which saves in assembly and obviates the possibility of any of the parts being mislaid or lost. The hanger is made entirely of zinc and will not rust. The operation of putting them up is very simple.

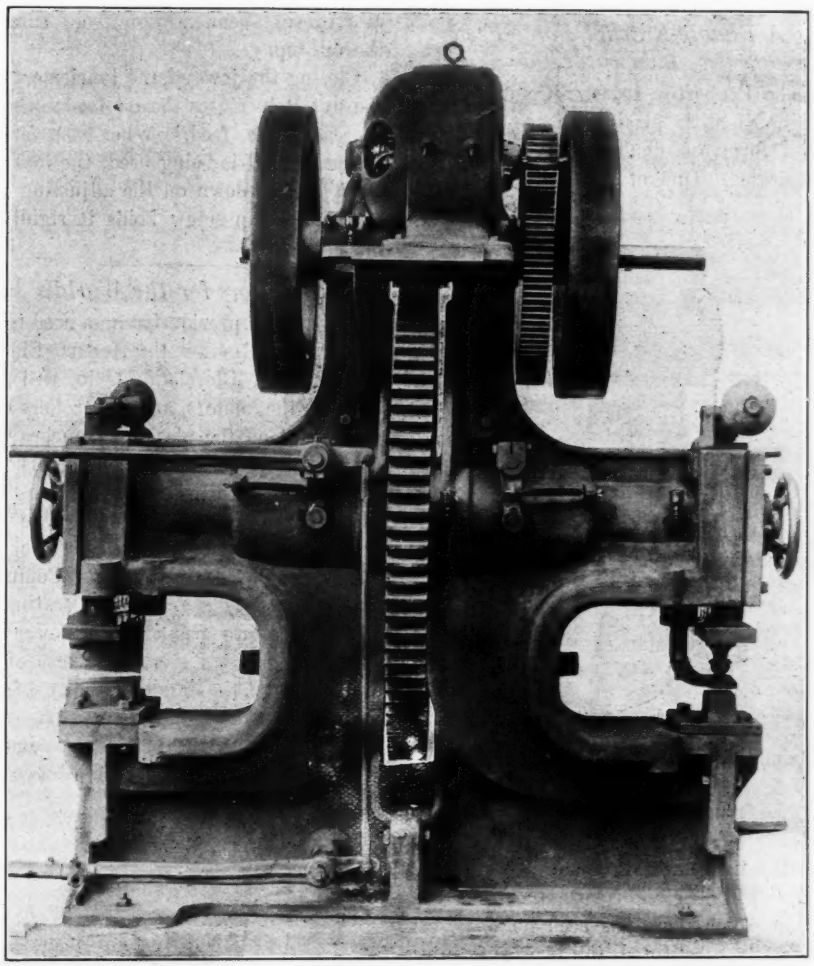
These hangers are strong and will not allow the cable to slip, but have a tendency to tighten with each strain on the suspension wire. They are now being

H-P Cable Hanger.

made in all sizes from ten and one-half inches to eighteen inches, taking in cable from seven-eighths of an inch to two and one-eighth inches in diameter.

A Combined Punch and Shear.

Considering its capacity the accompanying double punch and shear is of a remarkably compact design and in its method of driving it is also particularly creditable. Although it is now usual, when driving this style of machine tool by motor, to mount the latter well up on the frame more or less out of the way, it is seldom that so unobtrusive a location is selected as the one shown here. Moreover, it has the advantage of applying the drive between the flywheels, and of accomplishing it without greatly increasing the distance between them. The short length of the shaft and the fact that it is of rather large diameter combine to remove all tendency to spring under the torsional strain to which it is subjected at the instant of cutting.



Motor-Driven Punch and Shear.

The motor is a five-horse-power semi-enclosed type Crocker-Wheeler machine and is supported upon a small cast-iron bracket which is bolted to the bearing pedestals of the flywheel shaft. The bracket and the train gears between the motor and intermediate shaft were the only special parts required. Fortunately the proper speed of the flywheel shaft was obtainable with but one gear reduction, and as the pinion on the motor is of rawhide it is practically noiseless. The flywheels have been proportioned so that their inertia capacity is sufficient to drive the punch or shear through the plate at the interval of the stroke, thereby relieving the motor of the damaging shock and liability to spark that accompanys a suddenly applied overload.

The main gear near the centre has accurately cast steel teeth and runs smoothly. Clutches, having both hand and foot control, may be operated to connect or disconnect it to either of the eccentric shafts that raise and lower the tool heads, therefore either side of the machine may be caused to act independently of the other or both may be worked together. The eccentric shafts are made of steel and are of large diameter to afford ample wearing surfaces, and the eccentric boxes are of phosphor-bronze.

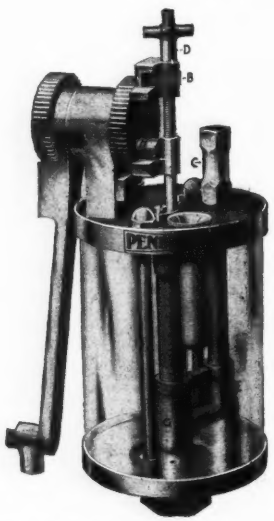
The machine has an eighteen-inch depth of throat on both sides and lower jaw pieces which may be removed to facilitate the punching of I-beams and channels. On the shear side the machine is capable of cutting a length of six inches through a three-quarter-inch plate, or a one and

one-quarter-inch round bar, and on the punch side it is capable of punching one-inch holes through three-quarter-inch iron.

The Royersford Foundry and Machine Company, of Royersford, Pa., is the builder of this combined shearing and punching machine and also of a line of combined and single end machines in various sizes and for almost all purposes.

A Double-Ratchet Force-Feed Lubricator.

The Penberthy Injector Company, Detroit, Mich., is placing on the market a new form of double-ratchet force-feed lubricator. One of the features of this



Double-Ratchet Force-Feed Lubricator.

device is the interchangeable ratchet drive wheels. This greatly increases the life of the lubricator, inasmuch as when the outer wheel becomes worn the inner one, upon which there has been no wear, can be easily substituted, the two being interchangeable in their different positions. Special attention has been given to all wearing parts, and ample bearings and high-class material have been used in the manufacture of this lubricator.

The regulation device is simple and easily adjusted. The valves are in the centre of the oil reservoir and are not affected by changes of temperature. It will feed lubricating oil that is difficult to feed through hydrostatic lubricators. The manufacturer claims that this lubricator will work perfectly on any engine or pump, regardless of the speed or pressure.

In connecting the apparatus, the lubricator is placed so as to get a connection from the operating arm to some moving part of the engine or pump. Pipe connection is made from the lubricator connection C to the steam pipe, keeping the engine throttle between the oil pipe and the engine.

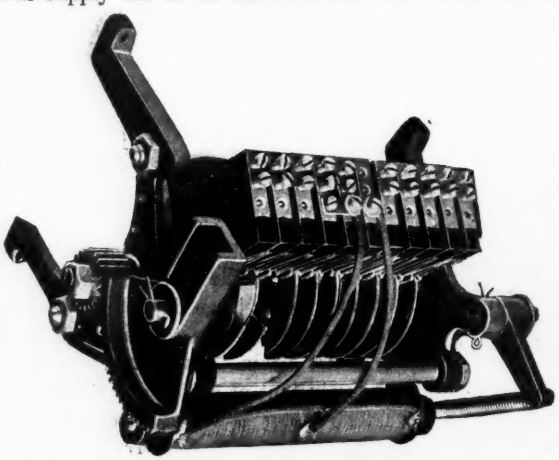
A globe valve is placed in the oil pipe close to the steam pipe, and an extra check valve is furnished with each cup, which should also be used. The threaded end of this check valve is screwed into the valve. This valve will prevent the oil being siphoned from the cup, and will also prevent condensation from entering the oil cup.

Closing the jaws of the lubricator with the nut B increases the oil feed; opening decreases the feed. When the proper amount of oil is being used, the lock nut D is screwed down on the adjusting jaw, and the set-up screw holds it rigidly in place.

Launch Motors for the World's Fair.

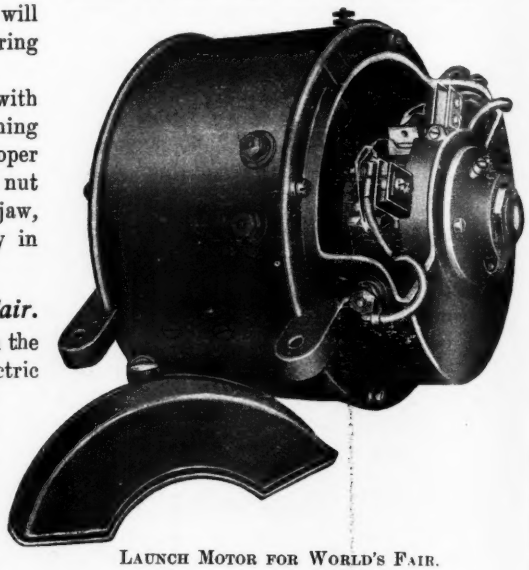
As has been previously announced in the Electrical Review, the Hertner Electric Company, of Cleveland, Ohio, will furnish the motors and controllers to be used on the pleasure launches at the St. Louis Exposition. This order calls for thirty special automobile motors and controllers. The boats are being constructed by the Truscott Boat Manufacturing Company, St. Joseph, Mich., and have a seating capacity of thirty passengers. Power will be furnished by a storage battery of the Willard type, having a capacity of 140 ampere-hours at eighty-eight volts.

The motors which the Hertner company will supply are of its standard two and



Type of Controller, with Launch Motors, for World's Fair.

one-half horse-power automobile type. These are multipolar with forged steel yokes and laminated pole-pieces. Ball bearings are used, and the bearings are so constructed as to take care of end thrust, as well as to give support radially. The mechanical and electrical design throughout is calculated to produce the highest possible efficiency. By the use of specially designed heads, the motors are made water-tight up to the level of the bearings. The upper part of the front head is left open, so as to expose the commutator and brushes. A removable cover is provided which will keep out all dust and water. The motors are supported in the boat by means of four lugs cast onto the sides



Launch Motor for World's Fair.

of the heads, and are lined up to the stuffing boxes through which the propeller shaft passes.

Three forward and two reverse speeds are given by the controller furnished. The first speed forward throws the motor on forty-four volts, with resistance in series with the armature. The second speed cuts out the resistance, and the boat moves at about a four and one-half mile rate, the motor making 600 revolutions per minute. For emergencies, the battery is thrown in series so that the motor operates under eighty-eight volts, and the boat has a speed of about six and one-half miles per hour. The backward speeds are on forty-four and eighty-eight volts, and correspond to the second and third forward speeds. When the controller handle is on the off position, the battery is connected in series and can be charged from a 110-volt circuit.

During the winter the New York Edison Company made a notable advance in the method of freeing a frozen water service. In one case, but fourteen minutes elapsed between the arrival and departure of the electrical apparatus.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

MEXICAN STREET RAILWAY SYSTEM CHANGES HANDS—The Mexican Light and Power Company, composed of Canadian capitalists, is about to acquire the Federal District Street Railway system of the city of Mexico. This system is owned by Worsher, Beitmeyer & Company, of London. The consideration is said to be $18,000,000.

A NEW YORK STATE ELECTRIC RAILWAY—A bill has been introduced in the New York state assembly by Assemblyman Apgar, making provisions for a four-track electrically equipped railroad extending for thirty-five miles between New York city and Croton. Two tracks will be used for fast trains, and two for trains running without schedule, after the manner of long-distance trolley lines. It is understood that the New York Central Railroad is the principal interest behind this bill.

NAVY DEPARTMENT TO MAKE CITY TESTS OF WIRELESS TELEGRAPHY—The Navy Department is making arrangements to institute a series of thorough tests, to be conducted between the Brooklyn navy yard and Navesink Highlands. The several systems of wireless telegraphy will be used. The principal object of selecting the two points named for the test is that the messages will pass across the city of New York, where there are a number of electrical influences to interfere. These tests will be preliminary, and it is intended later to try the systems between points farther distant.

FRANCHISE VALUES IN NEW YORK CITY—Special franchise valuations in New York city, as computed by the state tax commissioners, and on which the corporation franchise tax is levied, increased $16,363,725 over the aggregate for the previous year, the grand totals being respectively $235,157,725 and $251,521,450. In a number of instances the valuations were lower than the previous year, but in the majority of cases where changes were made the valuations show an increase. The new corporations receiving franchises in 1903 number but ten, and the total valuation of their franchises is but $16,300. This leaves the net increase in 1903 in the old companies $16,347,425. The largest increase is that of the Consolidated Gas Company, of New York, being $3,917,000, and the greatest reduction was in New York Telephone (Manhattan branch), $239,000. The larger of the increases are: New York Edison Company (Bronx), $70,000, and (Manhattan), $1,965,000; New York Mutual Gas Light Company, $251,500; United Electric Light and Power Company, $315,000; Empire Subway, $546,000; New York & New Jersey Telephone Company (Brooklyn), $428,000, and (Queens), $40,000; Brooklyn City & Newtown Railroad, $84,000; Bleecker Street & Fulton Ferry Railroad, $115,000; Christopher & Tenth Street Railroad, $100,000; Metropolitan Street Railway, $67,000; Union Railway (Bronx), $188,000; New York Central & Hudson River Railroad Company, $50,000; New York & Queens County Railroad, $70,000; Brooklyn Union Gas Company, $1,215,000; Central Union Gas Company, $306,000; Consolidated Telegraph and Electrical Subway, $733,000; Manhattan Railway, $2,600,000; Edison Electric Illuminating Company, Brooklyn, $1,034,000; Flatbush Gas Company, $70,000; New Amsterdam Gas Company, $227,000; New York Water Company, $75,000; Northern Union Gas Company, $65,000; Standard Gas Light Company, $50,000; New York Telephone Company (Bronx), $43,000; Western Union Telegraph Company, $30,000; Brooklyn City Railroad Company, $260,000. The largest of the decreases are: Brooklyn Union Elevated Railroad, $141,000; Dry Dock, East Broadway & Battery Railroad, $50,000; Forty-second Street, Manhattanville & St. Nicholas Avenue Railroad, $70,000; Long Island Railroad (Brooklyn), $55,000; Bush Electric Illuminating Company, $36,000; Citizens' Water Supply Company (Newtown), $144,000.

ELECTRIC RAILWAYS.

SUISUN, CAL.—An electric road franchise has been granted to J. W. Hartzell.

CORRY, PA.—The Erie, Cambridge Springs, Union City and Corry trolley line will be built this summer.

PEKIN, ILL.—The interurban line between Springfield and St. Louis will be completed to Carlinville by August 1.

GLADSTONE, MINN.—The Escanaba Electric Railway plans to extend its electric line from Escanaba to Gladstone.

BALTIMORE, MD.—A company with a capital of $300,000 has been organized to build an electric road from Salisbury to Crisfield.

INDIANAPOLIS, IND.—The Hammond, Whiting & East Chicago Electric Railway Company has increased its capital stock from $300,000 to $1,000,000.

STERLING, ILL.—The board of aldermen has granted franchises to the Dixon, Rock Falls & Southwestern Railway Company and the Rock River Traction Company.

SYRACUSE, N. Y.—Residents of Minoa have requested the Syracuse Rapid Transit Railway Company to extend its East Syracuse line to that place, a distance of four miles.

JACKSON, MICH.—The Lansing & Suburban Traction Company, organized to take over the property of the Lansing Street Railway Company and the Lansing & St. Johns Railway, has filed articles of incorporation with a capital of $1,000,000.

CINCINNATI, OHIO—The Dayton & Western Traction Company has filed articles of incorporation in Indiana, covering that portion of the road between Richmond and the Ohio state line. Valentine Winters and other Dayton capitalists are directors.

SUTTER CREEK, CAL.—Edward Records, of California, is promoting a project for an electric road to connect Ione, Jackson and Sutter Creek, a distance of fourteen miles. Electric locomotives will be used, and it is estimated that the work will cost about $150,000.

BATH, N. Y.—A franchise has been granted by the Bath town board to John Tuerk to construct the proposed electric line from Branchport on lake Keuka to Hornellsville through the town of Bath; from the Urbana town line on the north to the Avoca line on the west.

LEXINGTON, MO.—A proposition to build an electric railroad from Higginsville to Lexington Junction, connecting the Chicago & Alton and Wabash, has been submitted to the citizens of this city. The proposition submitted also includes the building of a bridge across the Missouri river.

SPRINGVIEW, NEB.—The preliminary survey for the electric railway from Springview to Newport will be made about May 1, and the president of the company which will build the road, Mr. C. E. Lear, states that the work will be pushed to completion just as soon as the survey is finished.

NORRISTOWN, PA.—It is stated that a trolley line to connect the villages of Trooper and Souderton will be built this spring. The line will connect the Schuylkill Valley Traction Company at Trooper, two miles west of Norristown, with the Lehigh Valley Traction Company at Souderton, about seventeen miles north of Norristown.

INDIANAPOLIS, IND.—The Consolidated Traction Company, which proposes to build a line from this city to Crawfordsville, by way of Clermont, Brownsburg, Pittsboro, Lizton, Raintown, Jamestown, New Ross and Limmsburg, has let the contract for designing, constructing and installing the electric and mechanical equipment of the road to Westinghouse, Church, Kerr & Company.

INDIANAPOLIS, IND.—The Fort Wayne & Wabash Valley Traction Company is now the corporate title of the electric railway

corporation whose properties include the Fort Wayne, Logansport and La Fayette city street railway lines, together with the interurban road connecting Wabash and Logansport. The change was made at a recent meeting of the stockholders held in Fort Wayne.

BOISE, IDA.—It is stated that the proposed electric railway to connect the town of Payette with Emmett, forty miles up the valley, will be constructed during the coming season. Those connected with the enterprise expect a road to be constructed this year from Boise to Pearl or Emmett, and they contemplate a connection either at Pearl or at Emmett which will give a through line between Boise and Payette.

LIBERTY, IND.—A fifty-year franchise has been granted to the Interstate Traction Company to extend its line from Dayton and Camden, Ohio, through this town to Connersville, Ind. The company also contemplates an extension to Chicago through a portion of the state now traversed by electric traction roads. It is promised that this division of the road will be completed for operation by December of 1905.

FARMINGTON, MO.—The stockholders of the St. Francois County Railway Company have elected the following officers: C. H. Bosworth, Chicago, president; William J. Cook, secretary, and Samuel A. Gillett, treasurer. The company absorbs the St. Francois County Electric Railway Company and will complete the line from Delassus to Flat River, *via* Farmington, a distance of twelve miles. It is stated that the road will be in operation by June 1.

SHARON, PA.—The Eastern Construction Company has awarded a contract for ten cars for the Cleveland & Sharon traction line, now building. The cars will be sixty feet long, equipped with air brakes, and will contain smoking apartments. A contract was also let for the power-house at Kinsman, Ohio. The run between Cleveland and Sharon will take only three hours and twenty minutes, the cars being built to make from sixty to seventy miles an hour.

TRENTON, N. J.—The Trenton, Lakewood & Atlantic Railway Company, which was chartered over a year ago with the object of constructing a road from this city to Lakewood, thence to Point Pleasant, to Belmar, with a direct branch from Lakewood to Asbury Park and Long Branch, will begin the work of construction at once. The president of the company is George O. Vanderbilt, of Princeton. William B. Willis is secretary and Abel B. Harling is treasurer.

NEW ALBANY, IND.—The Louisville & Southern Indiana Traction Company, operating the interurban line between this city and Jeffersonville and the local street railway lines of the two cities, has been granted a franchise by the upper board of the city council of Louisville to build a viaduct from the Big Four bridge and to lay a street railway track from the viaduct to Third and Main streets in the business centre of Louisville. The viaduct will cost $200,000, and officials of the traction company say it will be finished within six months and that cars will be running into Louisville before next autumn.

HARTFORD, CT.—The Hartford Street Railway Company has applied to the municipal authorities for an approval of its plans to extend its lines within the city limits. The company has also under contemplation the construction of some extensions of its suburban lines. The Connecticut Railway and Lighting Company is greatly enlarging the capacity of the power station for the Bridgeport division of its system. The plant has been extended and an 800-kilowatt generator, directly connected with a 1,200-horse-power engine, is now being installed. It will be at least two months before the new generator will be ready for use. The plant will then have a capacity of 3,600 horse-power, and will supply power not only for the local lines but for the Milford and Westport branches.

NIAGARA FALLS, N. Y.—The new power-house of the International Railway Company at North Tonawanda has been placed in operation. The house will furnish power for the Buffalo & Niagara Falls line between La Salle and the city line at Buffalo and also for the Buffalo & Lockport line and for the Buffalo & Kenmore line from the Buffalo city line to Gratwick. The equipment of the new power-house was installed by the General Electric Company, of Schenectady, and it has three 350-kilowatt rotaries. It has a 1,200-ampere-hour battery installed by the Electric Storage Battery Company. This battery, the officials claim, will do away with a great many delays in trolley service, as it will float on the power circuit and will be sufficient to carry the service for three or four hours should there be a burn-out at the Niagara Falls power-house.

NEW INCORPORATIONS.

NORFOLK, VA.—Blain Telephone Company. $4,000.

SANTA FE, N. M.—Pecos Valley Telephone Company. $50,000.

TOPEKA, KAN.—The Glasco Telephone and Telegraph Company. $6,000.

WILKINSON, IND.—Farmers' Cooperative Telephone Company. $1,000.

MINNEAPOLIS, MINN.—Neighbor State Telephone Company. $25,000.

VICTORIA, B. C.—Spruce Creek Power Company, Limited. $150,000.

ST. LOUIS, MO.—The Kinloch Long-Distance Telephone Company of Missouri. Increased from $300,000 to $5,000,000.

NARROWSBURG, N. Y.—Big Eddy Telephone Company. $8,000. Incorporators: G. W. Englemann, John Hessberg, D. W. Longstreet.

LEWISTON, ME.—The Somerset Farmers' Cooperative Telephone Company. $10,000. President, C. Rogers; treasurer, C. L. Hodgebrook.

ST. LOUIS, MO.—Sun Heat and Power Company. $10,000. Incorporators: Knut C. Wideen, Conde L. Benoist and Conde A. Benoist.

INDIANAPOLIS, IND.—The Farmers' Cooperative Telephone Company. $1,000. Incorporators: S. M. Overman, R. E. Simons, J. E. Burns.

BORDEN, IND.—The Laurel Telephone Company. $1,000. Incorporators: William R. Jackson, Edwin Packwood, F. M. Vance and E. Ross.

ST. PAUL, MINN.—The Electric 'Phone Company. $25,000. Incorporators: Henry E. Posely, Edward M. Schmitz, Edward Reinhardt and Frances A. Schmitz.

ALBANY, N. Y.—Sodus Gas and Electric Light Company, of Sodus, Wayne County. $15,000. Directors: G. S. Wride, B. S. Hopkins and H. L. Kelly, of Sodus.

INDIANAPOLIS, IND.—Liberty Center Telephone Company. $2,500. Incorporators: James P. Mounsey, Lewis A. Minnlear, Orin D. Garrett, Joseph Stahl and George M. Gavin.

VERNON TOWNSHIP, IND.—Vernon Township Telephone Company. $1,000. Incorporators: George M. Rumer, John Hiday, Creol Crawford, Colvin Jackson and Marion Chappel.

CAMBRIDGE, OHIO—Cambridge Railway, Light and Power Company. $500,000. Incorporators: R. V. Orme, H. O. Barber, William Moss, H. F. Wharton and C. D. Turnbaugh.

COLUMBUS, OHIO—The Cardington Electric Light, Heat and Power Company. $15,000. Incorporators: G. M. Schambs, W. E. Hull, W. P. Vaughan, A. E. Curtis and John W. Glauner.

DES MOINES, IOWA—Franklin Center Mutual Telephone Company. $2,000. Incorporators: C. M. Vanzee, D. D. Marsh, C. E. Smith, W. F. Langerbartaes, A. Juline, C. F. Kading and A. C. Niles.

WASHINGTON, D. C.—The General Traction Company. $15,000,000. Incorporators: Horace Moody, E. V. Nelson, N. D. Lancaster, James K. Polk, William A. Raborg, Fred. E. Queen and F. G. Polk.

CHARLESTON, W. VA.—Meadow Creek Railway Company. $10,000. Incorporators: Robert S. Gorham, Newton, Mass.; Roland Boyden, Francis G. Beckford, Beverly, Mass.; J. P. Hill, James F. Carroll, Boston, Mass.

DENVER, COL.—South Boulder Power and Development Company. $250,000. Incorporators: Seth W. Eddy, C. C. Sierk, Carl Feldhusen, Andrew Rosewater, Thomas A. Sanders, George W. Cutler, Edmund J. Churchill.

MADISON, WIS.—Rhinelander Power Company. $85,000. Incorporators: A. W. Shelton, E. A. Forbes, C. A. Wixson, Charles Chafee, R. C. Dayton, John Barnes, Matt. Stapleton, Paul Browne and E. A. Edmonds. Formed for the purpose of improving, developing and exploiting water power in the Wisconsin and other rivers.

TELEPHONE AND TELEGRAPH.

TROY, PA.—A telephone line is being erected from Austinville to Chandlersburg.

MONROE, IOWA—The Reasnor Telephone Company has been granted a local franchise.

KELLERTON, IOWA—The Kellerton Mutual Telephone Company will rebuild its system.

SULLY, IOWA—A telephone company has been formed to build to Kellogg, Newton and Pella.

DAVENPORT, IOWA—A new telephone line to connect McCausland and Princeton is in contemplation.

WINCHESTER, VA.—The city council has granted a thirty-year franchise to the Southern Bell Telephone Company.

ROCHESTER, N. Y.—A telephone line through Wayne and Bradford, connecting with Dundee and Hammondsport, is soon to be put in operation.

LEBANON, IND.—The Rees Mill Cooperative Telephone Company has incorporated with a capital of $1,000, and will operate in Zoone and Clinton counties.

GRAND HAVEN, MICH.—The Michigan Telephone Company is extending its lines out of Grand Haven into the townships of Grand Haven, Robinson and Olive, and will expend several thousand dollars in the work at once.

DAVENPORT, IOWA—An amendment to the articles of incorporation of the Iowa Telephone Company has been filed in the recorder's office, changing the location of the company's offices from Davenport to Des Moines.

PELICAN RAPIDS, MINN.—A local telephone company has been organized with a capital stock of $25,000. Work will be commenced as soon as the frost is out of the ground, the intention being to run lines into the surrounding country.

PHILADELPHIA, PA.—The construction of the new line of the Western Union Telegraph Company between West Chester and Philadelphia has been completed. Over 800 poles from fifty to seventy-five feet high have been placed.

COLUMBUS, GA.—The new automatic telephone exchange has made connections with the Adams lines. These extend down through several counties in southwest Georgia and southeast Alabama, operating mostly in the counties of Stewart, Clay, Randolph, Terrell and Webster.

OWINGSVILLE, KY.—Henry Watson, of Mt. Sterling, has purchased the plant of the Owingsville Telephone Company from C. S. Powell, of Richmond. Other lines may be built. Owingsville is now connected with all long-distance lines of the East Tennessee Telephone Company.

KNOXVILLE, TENN.—Work has been completed on the American Telephone Company's line which extends from Chattanooga to Cincinnati *via* Harriman, Knoxville and Asheville. All connections have been made between Chattanooga and Mobile, and all cities in the north and east may be reached.

NEW CASTLE, COL.—The Garfield County Telephone Company at its annual meeting elected the following officers: president, William Chadwick; vice-president, E. E. Clarkson; secretary, W. D. Lockard; treasurer, J. A. McRae. The company will extend its line to Glenwood Springs during the summer.

MEXICO, IND.—A telephone company has been organized at Mexico with a capital stock of $2,000. The town will be supplied with telephones and communication established with neighboring towns. The officers are: Lewis Bond, president; W. E. Fisher, vice-president; Leroy Graft, secretary, and J. T. Hood, treasurer.

MENOMINEE, MICH.—The Farmers and Merchants' Telephone Company, with a capital stock of $4,000, has been organized by A. W. Larson. The company has bought the Coleman-Timme telephone line and will extend it from Spruce to Lena, covering intermediate points. It is also intended to extend the line to Oconto Falls next fall.

RICHMOND, MASS.—The Richmond Telephone Company at a recent meeting chose the following officers: president, F. A. Clement; vice-president, Sidney M. Loveland; clerk and treasurer, C. P. Lovelace; general manager, F. A. Clement, being reelections in each case. Directors, A. G. Kiltz, C. H. Nichols, S. M. Loveland, J. H. Barnes, F. A. Clement.

CHARLESTON, S. C.—The Gordon telephone has been purchased by the Southern Bell Telephone and Telegraph Company. The sale was made several weeks ago, though no official announcement of the transfer of the property was made until recently. It is understood that the Bell company will operate the Gordon telephone plant independent of the Bell for a time, gradually merging it.

CHICAGO, ILL.—Telephone lines to enable the members of the fire department to communicate with the pumping stations and regulate the flow of water through the pipes are provided for. It is proposed to have 200 telephones in the system, some of which will be portable, to be carried to the scene of fire, placed on tripods and connected with the wires leading from the pumping stations and the headquarters of the fire department.

OKLAHOMA CITY, O. T.—Headquarters for the Pioneer Telephone Company, recently organized here with a capital of $3,000,000, has been established. The work of extending the lines of the company will be begun at once, and it is the intention to cover every city in the two territories and north Texas, and have connections with all parts of the United States, with direct lines to Kansas City, Omaha, St. Joseph, St. Louis and Dallas.

SPRINGFIELD, MASS.—The New England company contemplates increasing the service between Holyoke and Springfield by putting in operation nine additional lines with two additional to Chicopee. There are now nineteen lines between Springfield and Holyoke and two in operation between Holyoke and Chicopee by way of Springfield. The improvements will make a total of thirty-two lines between the cities instead of twenty-one.

TROY, N. Y.—At the annual meeting of the Hudson River Telephone Company these directors were elected: Charles F. Cutler, U. N. Bethell, James H. Manning, D. Cady Herrick, Thomas Sherwin, George P. Ide, John E. Adriance, Walter C. Humstone, Frederick P. Fish. The gross earnings for the year ended December 31, 1903, amounted to $883,885, and the operating expenses to $614,033, leaving net earnings of $269,852, as compared with $216,758 for 1902.

PAPILLION, NEB.—An independent telephone company has been organized among the farmers of Plattford precinct. It will be known as the Mutual Telephone Company and has sixteen charter members. The following are its officers: W. D. Schaal, president; D. Phelps, vice-president; J. H. Bundy, secretary; Z. T. Garman, treasurer. The farmers will do the construction work with the aid of an electrician. Work will be commenced as soon as warm weather opens up.

PULLMAN, NEB.—The Ewartsville Telephone Company has completed over fifty miles of overhead line. Commencing at Pullman, four wires have been stretched out five miles to the cross roads at the Roe Bryant place; two wires run from there south and southwest to nearly all the farms south of Union Flat and on the head of Almota creek. Two wires run down Willow creek from the Bryant place southwest past the Grange hall to the farms lying along Little Almota creek.

MONTREAL, CANADA—Official announcement is made that the Bell Telephone Company will soon issue $2,000,000 of new stock. Shareholders will be allowed to subscribe for the stock at 125 and pay for it in five instalments of $25 each. The proceeds will be used to develop the properties of the companies. The report for the year ended December 31, 1903, shows: gross earnings, $2,522,275; operating expenses, $1,940,123; net earnings, $582,152; dividends, $467,510; balance, $114,641; balance from 1902, $23,436; total, $138,077; insurance, accident and contingent funds, $97,542; surplus, $40,536.

RENSSELAER, IND.—The independent lines of Bruner and Merry and the Walleck systems have made a partial combination with the Jasper County Telephone Company of the Bell system. By the terms of the agreement the independent lines abolish their switchboards in Rensselaer and all their city business is absorbed by the Bell people. All the companies will still own and manage their farm and other out-of-town lines, but will all transfer over the Bell switchboard at Rensselaer. All subscribers on all the systems will have free exchange with all others. There will be over 700 telephones in the combined system.

ELECTRIC LIGHTING.

BEDFORD, MASS.—The town has voted to install electric lights.

AVOCA, N. Y.—An electric light plant will be installed by the village.

SODUS, N. Y.—The Sodus Gas and Electric Company has been granted a franchise by the town board.

BARTLETT, TEX.—It is reported that an electric light plant will be erected to supply Bartlett, Granger and Holland.

DENVER, COL.—W. O. Mossman and L. A. Holdredge, of Waldron, will establish an electric light plant in that town.

TROY, N. Y.—The Fort Edward trustees have granted a franchise to the Hudson River Electric Company to enter the village.

SPARTA, WIS.—At a special election the proposition to erect and operate a municipal lighting plant was voted down by a majority of sixty-five.

LIVERPOOL, N. Y.—The council has passed a resolution to light the village electrically.

YOUNGSTOWN, OHIO—B. M. Moss, of this city, is said to be interested in a move to establish a cooperative electric lighting and power plant, to cost $30,000.

PITTSBURG, PA.—The Allegheny County Light Company has secured the street lighting contract. This is for one year, the city paying $96 for each arc light.

TROY, N. Y.—W. C. Witherbee has secured a franchise for lighting the village of Port Henry with electricity. The power is to be obtained from Wadhams Mills.

NEW LONDON, WIS.—The city of New London has purchased the electric lighting plant from local capitalists for $5,000. Extensive improvements are planned.

RICHMOND, VA.—The senate has passed the bill to appropriate $25,000 for the erection of an electric plant to light and heat the governor's mansion and other buildings.

NAMPA, IDA.—B. G. Mullins and associates, of this city, will install a complete waterworks and electric light system at Glenn's Ferry. The estimated cost of the plant is $25,000.

CHARLOTTE, N. C.—According to the new contract recently made for street lighting, the city will pay $54 per annum for the first 150 lights and $48 for each lamp in excess of this number.

CADIZ, KY.—E. E. Wash, of Cadiz, and J. Parsley, of Princeton, Ky., have been authorized by the council to install an electric lighting plant. The city is to pay at the rate of $80 per lamp per year.

OLYMPIA, WASH.—The Olympia Light and Power Company has placed in operation its new plant at Tumwater. The latter is operated by means of the falls of the Deschutes river, and cost $100,000.

MARSHFIELD, WIS.—The city council has bought the Marshfield Electric Light and Power Company's plant and entire outfit for $150,400, $25,000 of which is to be paid during the next five years in annual instalments of $5,000, with interest at six per cent. The question of buying this plant has been considered at various times by the city during the last two years.

DAYTON, TENN.—The board of aldermen has granted a franchise to Thomas Edgar Stone, authorizing the use of the streets for the installation and operation of an electric light plant. The franchise is limited to a period of fifteen years, and work must be begun on the erection of the plant before the first of October next. The city also reserves the right to condemn and purchase the plant at any time it may so elect.

ALBANY, GA.—The city council of Albany has approved the contract which was submitted by the Albany Power and Manufacturing Company, which is to develop the water power at Big Shoals, on the Muckafoonee creek, two miles north of the city. The contract provides that the power company shall furnish 300 electrical horse-power at the city's electric plant at a cost of $8,000 per annum. The contract covers a period of ten years, and provides that the power shall be furnished by October, 1905.

ROCKVILLE, MD.—A bill has been prepared for introduction in the Maryland legislature authorizing the mayor and council of Rockville to issue bonds to raise an amount not exceeding $5,000 for enlarging and repairing the town's waterworks and for restoring and equipping the electric light plant. Both plants were installed about ten years ago at a cost of about $40,000. The waterworks has given general satisfaction, but several years ago the electric light plant was disabled by fire and the town has since been lighted by gasoline.

JERSEY CITY, N. J.—The report of the United Electric Company for the year ending February 1 shows that the profits of the company were $95,905.29, an increase of about $50,000 as compared with those of the preceding year. The gross receipts for the last fiscal year were $2,065,730.22, and the operating expenses and taxes amounted to $1,252,853.54. The net earnings were $852,876.68, and the fixed charges $736,971.39. The gross receipts for 1899 were $1,258,338, so that the increase in the four years since that report was made is over sixty-four per cent.

ATLANTA, GA.—Although the contract does not require the completion of the Bull sluice dam in the Chattahoochee river till January, 1905, it is expected that the work will be completed in August next. The dam is 1,000 feet long, rising fifty feet above the bed of the river, having a width of sixty-five feet at its base and fifteen feet at its top. It will cost $1,500,000. The 14,000 horse-power secured will furnish electric light and power to Atlanta. The Atlanta Water and Electric Power Company is the name of the corporation that has built the dam, and 500 men are at work on the undertaking.

LEGAL NOTE.

PATENT SOCKET LITIGATION—The United States Circuit Court for the Eastern District of Pennsylvania has handed down an opinion sustaining the Perkins socket patent No. 626,927. The case is to be referred to a master to ascertain the profits and damages to be awarded the complainant, the Perkins Electric Switch Manufacturing Company, Bridgeport, Ct.

PERSONAL MENTION.

MR. C. H. KRETZ is reported to be interested in a movement to build an electric light plant at Baton Rouge, La.

MR. E. W. RICE, JR., has been elected a director of the General Electric Company, Schenectady, N. Y., in place of the late William C. Whitney.

COLONEL ROBERT C. CLOWRY, president of the Western Union Telegraph Company, is visiting Cuba, where he will enjoy a well-deserved vacation.

MR. A. M. MATTICE, chief engineer of the Westinghouse Machine Company, Pittsburg, Pa., has been made chief engineer of the Allis-Chalmers Company.

MR. FRANK R. COATES, chief engineer of the Chicago Great Western Railroad Company, has resigned his position to enter a Chicago, Ill., firm of railroad contractors.

MR. J. C. GILLETT has been appointed master mechanic of the Columbus, Delaware & Marion Electric Railroad Company, to succeed Mr. G. G. Crane, resigned.

MR. PAUL F. WILLIAMS, formerly of the Chicago Edison Electric Company, has been appointed superintendent of electric lighting in the department of electricity at the St. Louis fair.

MR. LOUIS A. FERGUSON, past president of the National Electric Light Association, and general superintendent of the Chicago Edison Company, was a New York and Boston visitor last week.

MR. E. W. ABBOTT, formerly manager of the Southern New

England Telephone Company's exchange at Norwich, Ct., has been transferred to New Haven, to succeed Mr. C. J. Benjamin.

MR. W. K. PALMER, M. E., has announced the removal of his offices to the Lyceum Building, Kansas City, Mo. Mr. Palmer was formerly located in the New York Life Building, Kansas City.

MR. ALEXANDER C. BIRNIE, who was general manager of the Springfield Construction Company for some time past, has been appointed assistant engineer of the United Construction Company, of Albany, N. Y.

MR. R. H. MANSON has resigned his position in the sales department of the Kellogg Switchboard and Supply Company to accept the position of first assistant engineer of the Dean Electric Company, Elyria, Ohio.

MR. CHARLES P. PLATT, formerly representative of the Kellogg Switchboard and Supply Company on the Pacific coast, has accepted the position of representative of the Automatic Electric Company, of Chicago, Ill., to cover the same territory.

MR. EDWARD H. STEVENS has been made general superintendent of the electrical department of the Public Service Corporation of New Jersey. Mr. Stevens was for eight years superintendent of the Elizabeth station of the United Electric Company.

MR. FRANK P. FOSTER, secretary of the International Association of Municipal Electricians, was a visitor to New York during the week. The executive committee of the association will hold a meeting on April 2, at 10 o'clock, at the Astor House, New York city.

MR. ALFRED GREEN, who was chief electrician and master mechanic of the Rochester Railway Company for a number of years past, has resigned his position. Mr. Green does not anticipate taking up new work for some time, as he desires to take a much-needed vacation.

MR. PHILIP FRANSWORTH, formerly of New Haven, Ct., who acted as counsel for the General Electric Company, Schenectady, N. Y., for some time past, has removed his offices to 150 Nassau street, New York city, N. Y., where he will continue the practice of general patent law.

MR. SAMUEL HIGGINS, who is at present mechanical superintendent of the Southern Railway, with headquarters at Washington, D. C., has accepted the position of general manager of the New York, New Haven & Hartford Railroad to succeed Mr. W. L. Chamberlain, resigned.

CAPTAIN L. C. HANNA, brother of the late Senator Hanna, was elected a director of the Cleveland Electric Railway Company, at a recent meeting, to fill the vacancy caused by the death of his brother. At the same meeting appropriate resolutions on the death of Senator Hanna were adopted.

MR. H. J. PIERCE, of Buffalo, N. Y., president of the Netherlands Tramways Corporation, has returned from a recent trip to Holland. The Netherlands Tramways Corporation was incorporated last year under the laws of Connecticut, for the purpose of building and operating electric traction systems in Holland. Mr. Pierce was accompanied by Mr. Thomas E. Mitten, general manager of the International Traction Company's lines, of Buffalo. The main system of the Netherlands Tramways Corporation will be built between Haarlem and Amsterdam. Another line will go to Zandvoort, one of the leading Dutch seaside resorts.

MR. W. A. STADELMAN, eastern manager of the Brown Hoisting Machinery Company, New York city, is chairman of the entertainment committee of the New Rochelle Yacht Club. Mr. Stadelman has written a sketch entitled "Babes in Yachtland," which is pronounced extremely funny by those who have read it. It will be acted by some seven or eight club members on the occasion of the grand vaudeville and dramatic entertainment given by the New Rochelle Yacht Club, Saturday evening, April 9, in the New Rochelle theatre. A number of other sketches will be presented that evening, and under Mr. Stadelman's expert management the occasion promises to be highly successful and enjoyable.

ELECTRICAL SECURITIES.

Beginning with the first day's business of last week the stock market took on a distinctly improved tone. The trading was animated, and dealings fairly approached boom conditions. This was a very welcome situation for the commission houses, which have suffered severely during the past several months of sluggish dealings. While the improved condition of prices is a hopeful sign, it is regarded in many quarters as being distinctly artificial and the result of manipulation. Whether the interests which have promoted this rise in values will be able to maintain the buoyancy is yet to be proved. The general conditions, however, are such that improvement might well be looked for, and there are many reasons why the apprehension of a dull spring should be entirely discounted.

ELECTRICAL SECURITIES FOR THE WEEK ENDING MARCH 26.

New York:	*Closing.*
Brooklyn Rapid Transit	43⅛
Consolidated Gas	197¾
General Electric	165
Kings County Electric	184
Manhattan Elevated	142½
Metropolitan Street Railway	110½
New York & New Jersey Telephone	141
Westinghouse Manufacturing Company	175

A dividend of $2 per share will be paid on April 15 to stockholders of record of the General Electric Company at the close of business hours on Thursday, March 24. The transfer books will not be closed. It is stated that the company will show an increase in its earnings for February and March of nearly 10 per cent each month as against the corresponding month of last year. The annual meeting of the stockholders of the General Electric Company will be held at the company's office in Schenectady, N. Y., on Tuesday, May 10, at 12 o'clock noon, for the election of directors for the ensuing year and for the transaction of any other business which may come before the meeting. A special meeting will be held at 2 P. M. of the same day for the purpose of voting upon the proposition to increase the capital stock $3,325,500. The stock transfer books will be closed April 9 and reopen May 11.

A quarterly dividend of 2½ per cent upon the preferred and the assenting and non-assenting stocks of the Westinghouse Electric and Manufacturing Company will be paid April 11 to stockholders of record at the close of business on March 28. Transfer books will remain closed from March 28 to April 12.

A dividend of 1½ per cent will be paid on April 15 to stockholders of record of the New York & New Jersey Telephone Company as of April 5.

Boston:	*Closing.*
American Telephone and Telegraph	124
Edison Electric Illuminating	234
Massachusetts Electric	72½
New England Telephone	120
Western Telephone and Telegraph preferred	75

The directors of the New England Telephone and Telegraph Company have declared the regular quarterly dividend of 1½ per cent, payable May 16. Books close April 21 and reopen May 6.

For the four months of the fiscal year of the Massachusetts Electric Companies ending January 31, the net earnings show an increase of $52,000 as compared with those of the previous year.

Philadelphia:	*Closing.*
Electric Company of America	8
Electric Storage Battery common	56
Electric Storage Battery preferred	56
Philadelphia Electric	5⅞
Union Traction	48⅞
United Gas Improvement	84¼

A dividend of 1¼ per cent was paid April 1 to holders of both the common and preferred stock of the Electric Storage Battery Company.

Chicago:	*Closing.*
Chicago Telephone	117
Chicago Edison Light	148
Metropolitan Elevated preferred	47
National Carbon common	29
National Carbon preferred	100
Union Traction common	5
Union Traction preferred	30

INDUSTRIAL ITEMS.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, is distributing its bulletins Nos. 4 and 5. In bulletin No. 4 is described and illustrated an electric coal mining plant. Bulletin No. 5 treats on storage battery industrial locomotives. Both bulletins will be sent on request.

MUNROE & MUNROE, managers Marconi Underwriting Syndicate, New York, Boston and Montreal, and publishers of the *Marconigram*, is sending out the March, 1904, number. This bulletin contains an interesting article on "Marconi Developments of the Past Month," along with other interesting and instructive matter.

THE CROWE METAL MANUFACTURING COMPANY, 71 West Jackson Boulevard, Chicago, Ill., illustrates a number of types of its stampings in a new catalogue which it has just issued. This company is the manufacturer of the Crowe patented labor-saving machinery for the production of ornamental and indestructible metal advertising cards.

ROSSITER, MacGOVERN & COMPANY, Whitehall Building, 17 Battery place, New York city, has removed its St. Louis office from the Missouri Trust Building to its factory at Papin street and Compton avenue, St. Louis. On account of the large amount of business the company was doing in that city this move was necessary, as there are greater facilities for handling material direct from the factory and warehouse.

THE THOMAS E. CLARK WIRELESS TELEGRAPH-TELEPHONE COMPANY, Detroit, Mich., will be pleased to send its bulletin No. 10, giving facts about wireless telegraphy. This bulletin describes the instruments for wireless telegraphing and shows a number of typical installations. There is also a treatise on space telegraphy by Mr. Thomas E. Clark. The factories, laboratories and test stations are at Pontiac, Mich.

THE F. BISSELL COMPANY, Toledo, Ohio, has sent out its bulletins Nos. 27, 28 and 37. Bulletin No. 27 treats on field regulators, theatre dimmers, theatre switches and electric bunch lights. No. 28 shows and describes circuit-breakers and oil switches, and in No. 37 is illustrated and described electrical house goods, such as annunciators, call systems, telephone systems, push-buttons, bells, buzzers, etc. Bulletins will be sent on request.

THE NEW YORK EDISON COMPANY, 55 Duane street, New York city, N. Y., publisher of the *Bulletin* of the New York Edison Company, has issued its March, 1904, number. On the cover is shown an interesting picture of the Broadway Theatre, in which full Edison service is to supersede the private plant. The *Bulletin* contains many interesting articles, and a special feature is a full page reproduction of a photograph of Mr. Edison.

THE NERNST LAMP COMPANY has recently established district sales offices at 908 Pine street, St. Louis, Mo., with Mr. H. M. Reed as sales manager, and at 1619 Glenarm street, Denver, Col., with Mr. R. D. Marthens as sales manager. Both of these offices will carry a complete stock of Nernst lamps and supplies, and will be provided with an attractive exhibition room in which the different types of Nernst lamps will be shown in actual use.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY in bulletin No. 1023 describes type "B" motors. On the first page is an illustration of a type "B" open motor mounted on a subbase. There are also illustrations of the enclosed motor, the armature of the motor and the motor dismantled. The bulletin gives an accurate description, together with rating of weights of type "B" motors and generators, both shunt-wound and compound-wound, for slow and moderate speeds.

THE CHICAGO ENGINEERING AND CONSTRUCTING COMPANY announces that on or about April 25 it will remove its offices to suite 1301-1305 Great Northern Building, 77 Jackson Boulevard. The company is fully equipped to carry on the actual construction of electric railways, electric lighting plants and steam railways. The announcement states that when propositions are presented which are especially attractive, the company will assist in financing them.

THE NORTHERN ELECTRICAL MANUFACTURING COMPANY, Madison, Wis., in its bulletin No. 35 describes a complete line of multipolar motors. The cover page of this bulletin illustrates the spherical motor, universal motor, vertical motor, ring-type motor, steel-box-type crane motor, electric grinder and back-geared motor. A careful description is given of the construction and design of the Northern motors. This bulletin will be sent upon request to the company.

THE AMERICAN STEEL AND WIRE COMPANY, Chicago, New York, Denver and San Francisco, manufacturer of wire tacks, has issued a circular listing its "American" wire carpet tacks, "American" wire upholsterers' tacks, and "American" wire bill-posters' or railroad tacks. On the front cover of circular is shown a tri-colored package of "American" wire tacks in actual size. This circular should be in the hands of everyone contemplating the purchase of tacks. Circular will be sent on request.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., is issuing two new circulars, Nos. 1077 and 1078. Circular No. 1077 treats very fully on the Westinghouse type "L" motors, direct current and series wound. It is stated that these motors are widely used for hoisting or other intermittent service requiring a large starting torque. Many interesting halftones are shown, and in the back of circular are curve sheets showing the efficiency of these motors. No. 1078 illustrates and describes the Westinghouse No. 91 single-phase railway motor and car equipment. The circulars will be sent on request.

THE STERLING ELECTRIC COMPANY, La Fayette, Ind., has just completed a large extension to the telephone switchboard at the main exchange of the Home Telephone Company, of Toledo, Ohio. This extension will add a thousand telephones to the capacity of the exchange, making its equipment 7,000 lines. The cost of the extension was $29,000, making the total expenditure $148,000 for the Home Telephone switchboard. The switchboard is arranged in horseshoe form, and if stretched out would be 175 feet in length. There are fifty-five operators. Work was begun on the first of November, and it took twelve men four months to complete the contract.

THE H. W. JOHNS-MANVILLE COMPANY, 100 William street, New York city, is having considerable success in securing large orders for its new fireproof insulation, "Niagrite." This insulation takes its name from the first installation upon which it has been used, the Niagara Falls Power Company. "Niagrite" is made in several thicknesses, from three-thirty-seconds to three-eighths of an inch, and is supplied in strips thirty-six inches long and three inches wide. There is sent with each order sufficient fireproof glue in which to immerse and coat the strips to prepare them for application. The strips are wound spirally about the cable to be protected. The composition will dry out, under ordinary conditions, in about twenty-four hours and become very hard and absolutely fireproof.

THE STANDARD UNDERGROUND CABLE COMPANY, Pittsburg, Pa., announces the recent opening of a branch office or headquarters in the Security Building, St. Louis, Mo. This office is in charge of Mr. W. A. Caldwell, who was formerly connected with the Chicago office of the company, but more recently with the home office at Pittsburg. Mr. Caldwell had a number of years' experience with the company in both the construction and sales departments. This company has now seven district or branch offices throughout the country. These are as follows: the northeastern sales department, Delta Building, Boston, Mass.; the eastern sales department, 56 Liberty street, New York city; the southeastern sales department, Betts Building, Philadelphia, Pa.; the central sales department, Westinghouse Building, Pittsburg, Pa.; the western sales department, the Rookery Building, Chicago, Ill.; the southwest sales department, Security Building, St. Louis, Mo.; Pacific coast sales department, Crossley Building, San Francisco, Cal.